

SCIENCE

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THE BROADER ASPECTS OF RESEARCH IN TERRESTRIAL MAGNETISM¹

It has become the custom—fortunately or unfortunately as the case may be—that the retiring presiding officers talk on a particular subject, announced some time ahead, instead of being permitted to indulge in merely general reviews, as is the case in some organizations. Before I had a chance to think definitely on the matter, request was received from the permanent secretary four months ago that the title be furnished him at the earliest possible moment.

My original desire was to have the opportunity of talking to you on some more general subject than the one I have finally chosen. The topic, magnetism in general—a review of our fundamental ideas, the status of researches on the question “What is a Magnet?”—appealed to me strongly. In connection with my researches in terrestrial magnetism, I have naturally been obliged to look occasionally out beyond and raise questions on the general problem of magnetism. When not only the permanent secretary, but the secretary of this section and the present chairman, began to make inquiries as to my subject, I had to settle upon something. And when I turned to your chairman for assistance in coming to a decision, and submitted to him several topics, *e. g.*, “The General Problem of Magnetism,” “The Physical Bearing of Problems of Terrestrial Magnetism,” etc., he indicated his preference for one relating

¹Address as retiring vice-president and chairman of Section B (Physics), American Association for the Advancement of Science, given at Minneapolis, Minn., December 29, 1910.

to terrestrial magnetism, for he said, "A man usually talks best on the subject he knows best." Note the diplomatic and graceful manner in which he intimated to me that I might possibly know a little more as to the earth's magnetism than of magnetism in general. However, since magnetism is one of his own particular fields of research, may we not hope that he will decide to talk to us about this broad subject himself when he reaches the retiring age?

In fact, I am quite ready to confess ignorance of the most absolute kind on the whole subject of magnetism, terrestrial as well as general. And I am all the more willing to do so because I find myself in excellent company. Was it not von Helmholtz who characterized "magnetism as the most puzzling of natural forces"? Did not Rowland say that next to gravity, the greatest problem is that of terrestrial magnetism? Was it Lorentz who said that our ignorance in magnetism is the disgrace of modern physics, or words to that effect?

On the whole, it perhaps does seem best that one should talk, as far as he can, on an occasion like this, concerning a subject from his own directly acquired knowledge. As a retiring president of the British Association some years ago aptly said, when apologizing for confining himself chiefly to his own immediate subjects instead of attempting a complete general survey of the progress of science: "Partial views are better than inexact ones; and provision is made for their completion in the annual change of your officer."

I must take it for granted that I owed the honor of my election as vice-president and chairman of this flourishing section, two years ago, to the fact that it has been my privilege to contribute something towards the stock of our knowledge of the earth's magnetism. I may therefore as-

sume that you want me in the first instance to "reveal myself in my own subject." I will then only ask one favor of you in return, that you allow me to omit more or less wearisome details and deal to-day only with some of the broader aspects of terrestrial magnetic research.

Professor Arthur Schuster, during his visit to Washington last September, one day remarked jokingly to the speaker, "I am not quite sure whether it has really been best to have a special journal on terrestrial magnetism for gathering in the chief papers. For when no such organ existed physicists *saw*, at least occasionally, an article on the subject in their journals, even if they did not read it." The presumption evidently was that physicists nowadays have less opportunity for imbibing knowledge on terrestrial magnetism and kindred subjects.

So then, if I, a *terrestrial* magnetician, may be pardoned for knowing but little of magnetism, or, for that matter, of physics in general, possibly the *pure* magnetician or the pure physicist would likewise in turn have a valid right to ignorance in terrestrial magnetism and cosmical physics, were it not for the contradictory fact that he is often found to be the author of our encyclopædia articles on these very topics. His wisdom in these particular fields appears to be gained in that wholesome and unwearisome manner employed by Herbert Spencer, who "never began by attempting to learn what had already been said." "All my life," said he, "I have been a thinker and not a reader, being able to say with Hobbes that 'if I had read as much as other men, I should know as little as they.'"

We are to spend a few moments together to-day in looking at some of the broader aspects of physical research in a field that, with justice, many of you may look upon

as an exceedingly special and restricted one and perhaps even question its right to be classed among the physical sciences. And yet this subject of the "earth's magnetism," which may consider itself fortunate if a brief section is devoted to it in the average text-book of physics, is itself so broad and so extensive that I know of no single investigator who could to-day be regarded as equally eminent in all its various branches and sub-branches. To be a master in terrestrial magnetic research requires the most intimate knowledge of several of the so-called fundamental sciences, especially of mathematics, physics and geology, with some knowledge of astronomy, meteorology, chemistry and geography besides. "The field of investigation," says Maxwell, "into which we are introduced by the study of terrestrial magnetism, is as profound as it is extensive."

MAGNETIC DISTURBANCES

Instead of beginning with the phenomena usually chosen to illustrate the earth's magnetism, let us begin with one of the irregular, more or less spasmodic manifestations—one of the so-called "abnormal features"—the earth's "magnetic storms" as they were termed by Humboldt. Because of the troublesome nature of magnetic disturbances, when one is dealing with a phenomenon like the diurnal variation, for example, various magneticians for nearly three quarters of a century have been seeking some logical method of deciding just at what point a disturbance begins—in brief, how large must be the fluctuation in a magnetic element to be classed and eliminated as a "disturbance." Various rules have been set up, but none has found general acceptance.

There was a time when it was thought that, by mere inspection of the photographic record of the variations of a mag-

netic element during the day, it was possible to say whether that particular day was disturbed or not; and so arose in Great Britain, for example, what are called the "astronomer royal's five quiet days during the month." Through Airy's initiative, the first English magnetic observatory was established at the Greenwich Observatory during that period of intense magnetic activity which prevailed in the first half of the last century—during the days of Humboldt and Gauss. The honor of deciding on the five quietest days in any particular month from which the "normal" diurnal variation may be deduced, has therefore been accorded to the head of the Greenwich Observatory; these days are selected by him, or more likely by his magnetic assistant, from a mere inspection of the photomagnetograms. However, it has been found that these supposedly quiet days may themselves be subject to a more or less constant disturbance which, prevailing throughout the day, serves to elevate or depress the entire curve and hence does not reveal itself in superposed serrations or "eruptions." Or the disturbances may follow somewhat the same course as the diurnal variation itself, and hence again not be revealed by mere inspection, but serve mainly to increase or decrease the diurnal range.

Van Bemmelen and Chree have also found that these supposedly quiet days are subject to a non-cyclic effect similar to that shown by other days. I recall that during my first magnetic survey—that of Maryland, 1896-99—there were months when a searching examination of the photographic records of the magnetic observatories showed that there was hardly a day out of a whole month without some kind of irregularity.

It is then evident that a phenomenon which occurs so frequently and which in

fact appears ever to be present in some degree, at least, in the prevailing magnetic condition of the earth, is hardly to be treated as an outcast or as an "abnormal" feature. I very much question whether it will ever be possible to set up any rules which will separate scientifically the supposedly abnormal from the supposedly normal fluctuations of the earth's magnetism. I am rather inclined to believe that as progress is made there will be fewer and fewer attempts in this direction. On the contrary, *instead of eliminating a disturbance because it will not fit in with a particular mold or pattern, we shall learn that knowledge is mostly to be advanced by retaining it.*

In order to have something definite with which to deal I am going to ask you to confine your attention to-day chiefly to the abruptly beginning magnetic disturbances, bearing in mind, however, that not all magnetic storms begin thus. The first interesting question which arises regarding these sudden storms is whether, if referred to universal time—say, Greenwich mean time—they begin, within the limits of measurement, at the very same instant over the entire globe, or at least over a great portion of it. Up to the beginning of this year it was, indeed, generally believed that there was no measurable interval between the times of beginning of sudden disturbances even for very distant stations. The opinion was that the time differences which were revealed were only apparent ones, not real—that, if there were no errors of observation, they would vanish. So the belief arose that it might be possible to find the longitude between two distant stations by determining with the utmost accuracy the local mean times of identical perturbations, for, be it remembered, even the very smallest of these find their counterparts frequently at very remote stations.

A magnetic effect propagated with the velocity of electromagnetic waves would require but one eighth of a second to pass completely around the earth; if with the speed of a cathode ray, the circuit time would be on the order of a half or three fourths of a second. If then magnetic disturbances were propagated over the earth with such velocities, our present instrumental means would not suffice to detect any time differences between stations, though on opposite sides of the earth. If, however, differences of whole minutes are found instead of only fractions of a second, it will at once be seen that a most valuable clue has been obtained towards disclosing the nature and origin of our magnetic storms. It is my belief, furthermore, that *a long step forward will have been taken towards the solution of the origin of the earth's magnetism when once we have found out what causes it to vary*—what it is that can derange the magnetization of our entire planet to the extent of ten to twenty per cent. in the brief interval of a quarter of an hour, as actually occurred during the magnetic storm of September 25, 1909, the most notable of which we have any record. Referring to changes in the earth's magnetism, insignificant alongside of those just mentioned, viz., the secular changes, which only reach a comparable amount when integrated over a period of several centuries, Maxwell says: "When we consider that the intensity of the magnetization of the great globe of the earth is quite comparable with that which we produce with much difficulty in our steel magnets, these immense changes in so large a body force us to conclude that we are not yet acquainted with one of the most powerful agents in nature."

I would now like to call your attention to some interesting facts found with regard to 38 of these sudden disturbances which

occurred during the years 1882-1909. No. 1 of these is the unique magnetic disturbance of May 8, 1902, which, as far as can be ascertained, occurred simultaneously with the destructive eruption of Mont Pelé. On account of this interesting coincidence the records of twenty-five observatories in different parts of the world were collected and studied in my office. When the various scalings of the time of beginning of the disturbance were put together, they appeared to increase to the east, the effect apparently having been recorded first in Europe, next in Asia and last in America. The speed of progression was such that a continuous circuit of the earth around a great circle would require nearly 4 minutes, or in other words, the velocity was on the order of 100 miles per second or only about one two-thousandth that of light.

No. 2—the disturbance of January 26, 1903—was one investigated by the eminent physicist-magnetician Birkeland, the author of the cathode ray theory of magnetic disturbances. For this again an easterly progression, on the same order as for No. 1, was found.

Next, Nos. 3-19 are 17 storms between 1882-89 which were investigated by William Ellis, who was for a half-century in charge of the magnetic work at Greenwich.

The nineteen cases thus far mentioned showed a remarkable consistency in the direction in which the times increased, viz., to the eastward, only one sixth showing the reverse direction.

In order to test this result further with the aid of the best data immediately available, Mr. R. L. Faris, Inspector of Magnetic Work of the United States Coast and Geodetic Survey, undertook, at my request, a special examination of fifteen sudden storms between 1906 and 1909. He had to restrict himself for the time being

to the five magnetic observatories belonging to the United States, viz., Cheltenham (Maryland), Porto Rico, Baldwin (Kansas), Sitka and Honolulu, which extend over about one quadrant of the earth. Mr. Faris scaled the times of beginning with every possible care; he estimated that the error of measurement was about one half minute and certainly not over one minute. Yet the individual observatories differed by quantities ranging from 1.1 to 6.7 minutes! Here again, for 10 out of 15 cases, the direction of progression, over the limited portion of the earth embraced, was eastward, and for only one third was it westward.

The next four cases are some tiny preliminary disturbances preceding larger ones, investigated by the director of the Zi-ka-wei Magnetic Observatory, Father J. de Moidrey, and by Mr. Faris; for two of these the direction of progression was east, and for two, west.

Summarizing—for 28 out of the 38 cases the times of beginning increased eastward and for but 10, or about one fourth, the increase was in the reverse direction. The following conclusion was accordingly drawn:

Magnetic storms do not begin at precisely the same instant all over the earth. The abruptly beginning ones, in which the effects are in general small, appear to progress over the earth more often eastward though also at times westward, at a speed of about 100 to 200 kilometers per second, so that if a complete circuit of the earth were made it would require, on the average, between 7 and 3 minutes.

DIRECTION OF MOTION OF MAGNETIC DISTURBANCES

If it is a fact that magnetic disturbances are propagated more decidedly in one direction than another and that they dif-

fer, in this respect, from seismic disturbances which proceed in all directions from the center of disturbance, then a harmonic analysis of the disturbance effects should furnish further evidence. A definite electric or magnetic system must be accompanied by equally definite effects on our suspended magnetic needles. Knowing the latter, we ought, in turn, to be able to determine the general character, at least, of the producing system.

The beginning of the disturbance of May 8, 1902, may be taken as typical of the general type of perturbation thus far considered, viz., an increase in the horizontal intensity over the whole, or at least the greater part, of the earth, and a decrease in the vertical intensity in the northern magnetic hemisphere, and an increase in the southern. Applying a mathematical analysis, it is found that the system of forces which could produce the observed disturbance was a two-fold one—the first, the stronger, consisted of a set of electric currents in the upper regions, circulating eastward around the earth, if negative currents, and the reverse, if positive ones; the second, a weaker system, contained within the earth and possessing the characteristics not of an induced electric system, but of directly induced magnetism of the same sign as that of the earth's own field.

Please note that according to this analysis the disturbance system is chiefly an overhead set of currents proceeding, if negative ones, in an eastward direction around the earth—but this, in fact, is the direction in which the recorded times of beginning of the disturbance were found, in general, to progress. One method of investigation thus independently supports the other.

How may we suppose that negative electric currents are brought about in the

regions above us which could thus affect our magnetic needles? If the progression in the times of beginning of the effect may be interpreted as meaning that, whatever the cause, it is moving with a velocity measured by the differences in the times at distant points on the earth, then the resulting velocities are on the order of about one two-thousandth that of electromagnetic waves, or about one four-hundredth that of cathode rays. The question immediately arises—May not the required overhead negative electric currents be brought about by rapidly moving electric charges, whose accompanying magnetic perturbations are but an exhibition of the Rowland effect on a scale far transcending any laboratory experiment within the power of man? We may be dealing with ionic charges set in motion, as the result of a releasing action from some quarter, by sources of energy already existent in the regions above us, whence currents arise—

“Of power to wheedle

From its loved north the subtle needle,”

as Maxwell said with regard to the convection currents, which “that doughty Knight, Rowland of Troy, did obtain.”

Now before indulging in a bit of scientific imagination, let me caution you to distinguish carefully between what is fact and what is hypothesis. The results communicated respecting the differences and progression in the times at which sudden perturbations occur, as well as those derived from the mathematical analysis of the recorded effects, are independent of theory. You may not agree with me in any hypothesis which I may attempt to establish as to the cause of magnetic disturbances and the *modus operandi*, but please remember that the facts remain, however difficult may be the problems which they present.

HYPOTHESIS OF IONIC CURRENTS

According to the measurements of Rutherford and Zeleny, the average total ionic velocity for dry air at the earth's surface and an electromotive force of one volt per centimeter, is 3.2 cm./sec. At this rate it would take forty years to encircle the earth. Putting together all the facts of laboratory experiments at present available to me, including the work carried out at the laboratory² here by Zeleny and Kovarik, a provisional calculation appears to show that, for the atmospheric pressure prevailing at about the height of 75 kilometers, the ionic velocity would be of the order required for a circuit of the earth in about four minutes—hence, of the order found above to correspond with progression of the observed times of beginning of a sudden magnetic perturbation.

A mathematical analysis of the magnetic observations made at various points on the earth's surface has revealed the existence of a definite system of atmospheric electric currents whose magnetic effects are of sufficient magnitude to require their being taken into account when determining the so-called magnetic constants of the earth. Now if the atmosphere is made more conducting at any point, as the result, for example, of the ionizing effect from solar radiations, an extra current will be started and set in motion by the electromotive force existing at that point. The direction finally followed by the extra current will, however, not depend alone upon the prevalent electromotive force, but also upon the deflecting effect of the earth's magnetic field and of the earth's rotation on the electric carriers, and doubtless upon a variety of other conditions.

If a negative ion is set in motion at a given altitude in an eastward direction,

²The Physical Laboratory of the University of Minnesota.

the deflecting effect of the earth's magnetic field will be to bring it down closer and closer to the earth. But the ionic velocity decreases with decrease of altitude, hence the magnetic effect produced by the moving charge on a needle at the earth's surface will begin later and later, as the charge travels eastward. If, on the other hand, the negative ion starts westward around our planet, then the deflecting effect of the earth's magnetic field would be to make the charge move higher and higher and, hence, faster and faster. We might thus possibly have the following state of things: Due to some cause, electric charges are set in motion in every direction from a certain point overhead. Those with an easterly component of motion have their velocities checked in the manner just described, whereas those with a westerly component are made to move faster, so that for two stations, one east and one west, the magnetic effect is recorded later at the east station. This deduction you will observe would correspond with that actually found for the vast majority of the 38 disturbances above treated. In brief, the deflecting effect of our own magnetic field would be favorable towards the maintenance of easterly progressing negative ions, since by bringing them closer to the earth their effect is increased, and unfavorable for the westerly ones since they are made to move farther and farther away from the earth. Whether it is due to this fact that a sudden disturbance progresses more often to the east than to the west is an interesting query.

THE PECULIAR MAGNETIC DISTURBANCES OF
DECEMBER 29-31, 1908

I want to make you acquainted next with another set of most instructive magnetic disturbances which differs from the kind previously considered in several important

respects. The effect of the previous type of disturbance was to superpose, on the earth's existing magnetic field, a subordinate magnetic system possessing essentially the same characteristics as the primary field, differing from it only in degree—in brief it *increased* momentarily the earth's magnetization, and hence might be termed a "positive magnetic perturbation." It was also a world-field—its effects were recorded all over the earth.

But now we are to have examples of a "negative magnetic perturbation," whose effect is to superpose a magnetic field opposite to that of the earth, in short, diminish the earth's prevalent magnetization, and whose area of action is a comparatively restricted one. These perturbations were not felt over the whole earth within a few minutes of the same absolute time; instead the intervals between the recurrences in different parts of the earth were to be measured by hours and even a day.

Attention was first called to these peculiar magnetic disturbances by D. L. Hazard, of the United States Coast and Geodetic Survey, and recently R. L. Faris, of the same organization, has collected information regarding them from a large number of observatories over the globe. These disturbances did not extend much over one half hour and occurred on a practically undisturbed day. The maximum deflection in the horizontal component of the earth's magnetic intensity amounted to about one five-hundredth part. The complete data will be found given by Mr. Faris in the March, 1911, issue of *Terrestrial Magnetism and Atmospheric Electricity*. I am indebted to him for the privilege of making use of his data in advance of publication.

Four times out of eight cases the region over which the disturbance prevailed was the American continent and the Pacific

Ocean as far as Honolulu; in one case the region was limited to the Atlantic Ocean and the American continent; twice it occurred in eastern Asia and but once in Europe. Hence, had we been obliged to rely solely upon the magnetic records from the region of the earth, Europe, where the majority of magnetic observatories exist (about 20), we should have had to report but one magnetic disturbance between December 29 and 31, 1908, instead of actually eight. No fact known to me illustrates more convincingly than this the folly of increasing greatly the number of magnetic institutions in the same region of the globe. It also proves that, when dealing with general terrestrial magnetic phenomena, no such weight can be attached to the combined testimony of the European observatories as has heretofore been the custom. To give weight, as is frequently done, according to the *number* of existing magnetic institutions in any one region leads to totally erroneous results. We are reminded of the wise words of Joseph Henry which, though uttered in a different connection, apply with special force here, viz., "*Votes in science should not be counted, but weighed.*"

Now why is it that these particular magnetic perturbations were confined each time to but a portion of the globe? The intervals in time between the successive occurrences range from 1^h 5^m to 24^h 21^m, whereas the apparent velocities shown over the area covered at any particular appearance of the disturbance is on the order of the quantities as previously found for the first type of disturbance considered. The question immediately arises, therefore, as to whether we are dealing here with *two* velocities. Have we, for example, a vortex consisting of very rapidly moving electrical charges, an earth-spot, as it were, the vortex as a whole, however, moving

comparatively slowly over the earth? Or, are we to suppose that at each recurrence the disturbance was formed anew? No matter what view we adopt, it is evident that we are about to find out another important fact.

Determining the local mean time of the extreme stations at which the disturbance was recorded whenever it occurred, it is immediately seen that *only the observatories in the daylight zone were affected*. At those observatories where the local time was somewhere between 4 P.M. and 6 A.M., no effect was obtained. Hence, the conclusion is inevitable that *solar radiations of some kind must have played an important part in the production of these disturbances*. There were at the time on the sun's visible disk some peculiarly eruptive spots which may have to be held responsible for the peculiar magnetic disturbances.

A mathematical analysis of this type of magnetic perturbation is at present under way, but it has already become sufficiently evident that we are dealing here with a much more complex system than in our first type.

GENERAL DEDUCTIONS RESPECTING MAGNETIC DISTURBANCES

From the two types of disturbances considered it has been found that not only may our most sudden magnetic disturbances begin at measurably different times for various points on the earth's surface, but also that magnetic perturbations may even be confined to but a very limited portion of the globe.

The possibility of a regional magnetic disturbance was foretold with the aid of a law which I found to hold regarding magnetic changes in general:

"Alterations in the earth's magnetic condition, whatever their nature or origin may be, appear to be distributed over the

globe according to a law profoundly dependent upon that governing the distribution of the earth's own primary magnetic forces."

The prediction made on the basis of this law last spring, before the facts had become known respecting the disturbances mentioned, was as follows:

I confidently expect, as soon as a complete analysis has been made of magnetic disturbances covering the greater portion of the earth, it will be found, that the disturbance field, in general, presents all the characteristics of the terrestrial, primary one, the disturbances will themselves reveal effects from terrestrial, continental, regional and even local causes (earth currents, for example, whose path and intensity depend upon local character of soil, etc.).

Were this the place, I should like the privilege of setting before you the full import of this law. How, for example, we find characteristics in the magnetic fields composing the so-called permanent magnetization of the earth analogous to those which represent the systems producing the time variations. Suffice it to say that, if we were to establish a mathematical expression for the respective systems involved, the same terms would appear in the space variations as in those of the time. We might tersely put it thus: *"In terrestrial magnetism space and time are often relatively interchangeable."*

Before leaving the subject of magnetic disturbances let me point out to you two or three additional interesting facts which may serve to guide us in our study of causes.

It is the usual custom to exhibit the dependency of the fluctuations in the earth's magnetic condition during a sunspot cycle by means of changes in certain particular magnetic elements, as for example, the change in the amplitude of the diurnal variation during the sunspot cycle, this amplitude increasing with increased solar

activity. If, however, we make use of a more direct physical quantity, viz., the earth's magnetic moment, or let us say intensity of magnetization per unit volume, then we find that, *in general, during a sun-spot cycle the earth's magnetization decreases with increased solar activity.* In brief, on the average, the effect of magnetic perturbations is to superpose on the earth's magnetic field a magnetization opposite to that of its own, and hence the effect is one of demagnetization. The quantity involved is on the order of that found some years ago when I raised the question as to whether the earth is gaining or losing magnetism.

This question was attacked in two different ways; first, use was made of the existing magnetic charts between 1840 and 1885; secondly, freshly accumulated data between the years 1890 and 1900 were utilized. Both investigations led to the same result, viz., that *the earth's magnetic moment is at present being diminished by about one twenty-four hundredth part annually.* Now, if the terrestrial magnetician were permitted to make the same apparently violent extrapolation as is indulged in by the radio-physicist, he would find that, at the present rate of decrease, the earth's magnetic moment will have dwindled to one half of its present value in about 1,660 years from now. Note that this period is practically the same as that of radium decay—probably a mere coincidence!

We may make use of magnetic perturbations in another way, mainly, to get some idea of the *earth's magnetic permeability.* I have already pointed out above that when analyzing the effects of the magnetic disturbance of May 8, 1902, it was found that there were two systems involved, one an external one composed of overhead electric currents, and the other, an internal

one having the characteristics of directly induced magnetism. If we suppose that the second system is the result of the first, then the ratio of the potentials of the two systems will give us the differential change in the earth's magnetic permeability. Various calculations of this kind are under way.

One of the most important bearings of the facts above set forth regarding magnetic disturbances pertains to the slow, progressive changes to which the earth's magnetization is subject—secular changes. It has already been hinted above that these *secular changes can not be explained simply by a change in the direction of the axis of magnetization, but likewise imply changes in the intensity of magnetization.* Respecting the latter, our result was that apparently the residual effect of a magnetic disturbance is a diminution of the intensity of magnetization, which may last for some period after the cessation of the disturbance, two months, for example, as occurred with respect to the notable magnetic storm of September 25, 1909. Whether the earth ever recovers completely from a magnetic disturbance is questionable.

Now, *as to the effect of magnetic disturbances on the axis of magnetization,* let me merely point out that if magnetic disturbances do actually in general progress over the earth more often in one direction than in the other, the mechanical effect is to be reckoned with. If the progression is generally eastward, as appears to be the case, then the mechanical effect of the overhead currents will be to increase the velocity of the earth's rotation or, failing to do that, which is more probable, the effect will be to cause a displacement of the earth's magnetic axis eastward. We thus have disclosed to us one of the several systems causing the secular variation of the earth's magnetism which was pointed out in 1904

as the result of my analysis of the systems causing the secular variation.

The principal system, however, involved in the production of the secular variation is still to be revealed, and a promising line of inquiry, at present in progress, is the concomitant study of the laws followed by the secular variation and the lunar diurnal variation of the earth's magnetism; I have found that both follow remarkably similar laws in their distribution over the earth. It might also be mentioned here that owing to the non-commensurability in the periods of the solar-diurnal and the lunar-diurnal variations, there is an outstanding daily residual of the right magnitude for the production of the secular variation.

Sufficient has been given to show how important and fruitful is the study of the "abnormal" features of the earth's magnetism. It seems probable that we shall learn more from a close investigation of magnetic disturbances—of the irregular phenomena—than of the normal and regular features. In any event we find that the "abnormal" is such an intimate part of the supposedly "normal" that it seems unwise really to make a separation. We fully endorse the view of Schuster when he says:

Outbreaks of magnetic disturbances, affecting sometimes the whole of the earth simultaneously, may be explained by the sudden local changes of conductivity which may extend through restricted or extensive portions of the atmosphere. I have shown in another place that the energy involved in a great magnetic storm is so considerable that we can only think of the earth's rotational energy as the source from which it ultimately is drawn.

According to the views above set forth, the various manifestations of solar activity, sunspots, protuberances, etc., are not the direct but the indirect cause of the earth's magnetic storms. Their effect appears to be more in the nature of a releasing or "trigger" action, setting in operation elec-

tric forces already in existence in the upper regions of the atmosphere; terrestrial sources, in reality, however, supply the energy required for the magnetic storm.

THE EARTH'S PERMANENT MAGNETIC FIELD

Our studies began with magnetic disturbances, and we soon found that we were dealing with systems of forces remarkably similar to those composing the earth's permanent magnetic field. Given an existing electrical field in the upper regions, it follows at once, from our knowledge of the necessarily varying conductivity of the atmosphere resulting from solar radiations of various kinds, that this field must be an exceedingly variable one. First, it must be subject to a daily variation of an average normal kind corresponding to the average normal solar radiation, and superposed on this more or less spasmodic fluctuations, which represent the variability in the supply of the essentials in the solar radiations for producing the observed magnetic effects.

In this connection let me point out an interesting bit of evidence furnished during the time of the total solar eclipse which occurred in the United States in May, 1900. As the result of the special magnetic observations, made chiefly by the observers of the United States Coast and Geodetic Survey, a small magnetic perturbation revealed itself at each station along the belt from Georgia to Maryland. This perturbation did not begin according to absolute time nor according to local mean time, but bore a distinct relation to the time of passage of the shadow cone. It was thus shown that by the interposition of the moon between the sun and the earth, certain radiations were cut off as the result of which a magnetic fluctuation was produced. I recall that the late Professor Newcomb appeared rather skeptical as to

the possibility of a magnetic fluctuation due to such a cause until one day he put this query to me: "If a magnetic effect is produced when such a small body as the moon comes between the sun and the earth, why do we not have an effect every day owing to solar radiation being cut off from one half the earth by the other?" Professor Newcomb had momentarily forgotten that we do have a daily effect of the very kind he had in mind, viz., the diurnal variation, and when I pointed this out to him he appeared convinced as to the possibility of a magnetic effect likewise during a total solar eclipse. I have shown that the magnetic effect during a total solar eclipse is precisely similar to that of the diurnal variation, differing from it only in degree and that the amplitudes of the respective oscillations are in direct proportion to the areas of the interposing discs.

Please recall also that in the second type of disturbance above treated, viz., those of December 29-31, 1908, we had further evidence of perturbations occurring only in the daylight zone; the inhabitants on the other side of the earth did not experience the perturbations.

If then so much can be explained or, let us say, suggested, on the supposition of an existing primary electric field in the region above us, then it behooves us to do our utmost to find out all we can as soon as possible regarding this field. And here is where the great value of the extensive magnetic operations of the Carnegie Institution of Washington will be demonstrated, for the precise characteristics of that outside electric field can not be accurately determined until the completion of a general magnetic survey of the globe. When that has been accomplished, which we hope will be the case within the next five or ten years, then the constants, or rather the determining coefficients, can be derived for the

various constituent portions of the earth's total magnetic field.

Before closing this section let me call to mind a fact that is frequently overlooked, that *our only cognizance of the earth's magnetic field is through its external lines of force*. Cut these out, and we would conclude, in accordance with our usual test, that the earth was not magnetized. But we might have closed magnetic systems within the earth similar to that of a magnetized ring. Such a ring, however strongly it may be magnetized, has no outside magnetic effect and if we had no previous knowledge of its internal magnetization, we would conclude from our usual experiments that it is non-magnetic. I know of no method of disclosing such magnetizations as that of the ring without producing some mechanical change in the ring itself. Accordingly, our knowledge of the earth's primary magnetism would be confined wholly to external effects, were it not for the fortunate fact of the variations continually caused in the earth's magnetism by outside forces. You will therefore see the point to my statement that, in my belief, *it is useless to attempt an explanation of the origin of the earth's magnetism until we have found out what causes it to vary*. Perhaps even then it may turn out that we shall have to be content with simply raising the question already put by Schuster whether "every rotating mass may not be a magnet."

In this connection let me record here an interesting fact which I found some years ago. If we determine the earth's magnetic axis and intensity of magnetization per unit volume separately for various parallels of latitude, then there is a distinct connection shown in the values of the constants involved with the speed of rotation of a particle on the parallel concerned.

A BROAD VIEW

I began my address by setting before you some of the results of research in a field which I am ready to acknowledge appears, as I have already said, a very restricted and special one. But as we progress we are continually forced to raise questions which go far beyond our specialty and touch at the very heart of matters in which we all take a common and lively interest.

The all-comprehensiveness of terrestrial magnetic phenomena makes us more than ever aware of the necessity of taking broad views and keeping our minds ever open and free so that we may receive and weigh the facts observed with the proper care and in the proper scientific spirit.

The terrestrial magnetician is continually having forced upon him the fact that the "axis of the universe does not stick out of his own back yard." He can not follow the example of his more fortunate brother, the geodesist, who, from careful measurements made over but a very limited portion of the earth can determine its figure with wonderful precision, the best possible demonstration of which we shall have to-day from the address of the retiring chairman of Section D. To the geodesist a mass of lead is the same as an equal mass of magnetic iron ore; not so, however, to the magnetician. Were he to attempt the determination of the position of the earth's magnetic axis and of the earth's magnetic moment from a series of extensive magnetic observations in the United States, he would obtain results totally different from those similarly derived for an area of equal size in some other part of the globe. So likewise, as we have found with respect to the earth's magnetic disturbances, five well distributed magnetic observatories can accomplish more, viewed from a general, terrestrial standpoint, than twenty of the best equipped magnetic observatories con-

centrated in but a limited portion of the earth, however civilized that portion may be.

Thus the student of magnetism has difficulties not encountered in geodesy, and he would appear to suffer under great disadvantages. Perhaps, however, the disadvantages under which he labors as regards one object may become a source of advantage in a totally different one; by the very fact that to the magnetician a lump of iron is different from a similar mass of lead he is enabled to draw certain conclusions with regard to the materials forming the earth, denied to the geodesist. One of our foremost geologists has predicted that our knowledge of the internal constitution of the earth is to be advanced primarily through terrestrial magnetism and seismology.

Beginning with Gauss and up to within comparatively a few years ago, it was believed that it would be possible to establish a mathematical expression having a limited number of coefficients which would represent the magnetic observations made over the earth's surface, if not entirely within an error of observation, certainly within an error of approximately the same order. However, as carefully conducted magnetic surveys become more extensive, it is becoming more and more evident that it is useless, for practical purposes, to establish such mathematical formulas. Were we, for example, to have magnetic data all around the globe at intervals of five degrees in latitude and longitude, hence at 72 points on a parallel, it would be possible to set up a formula which should represent absolutely the values at the points given, but even for this case the expression would involve so many unknowns as to make the computation practically prohibitive. And after all this labor had been accomplished, it would not be possible to obtain the mag-

netic elements between the five-degree points and within the accuracy attainable even by ocean magnetic work. In fact the outstanding residuals would be on the order of 10 to 100 times the error of observation. This inability to represent the earth's magnetic condition by means of a closed mathematical formula having a definite physical interpretation might again be looked upon as a disadvantage. I, however, am inclined to look upon it as an advantage; for we have thereby a definite proof of the fact that magnetic observations are sufficiently delicate to disclose all of the heterogeneities and irregularities in the constitution of our earth. Had we time we might profitably spend a few minutes in looking at the testimony which may be furnished the geologist in this respect by the magnetic needle.

In conclusion permit me to refer to an incident which occurred at the meeting of the British Association held at Bristol in 1837. Sir William Hamilton, attending the session of the Chemical section and getting into a quarrel with his chemical brethren, remarked: "The nearer all the sciences approach Section A (mathematics and physics), the nearer they would be to perfection." I would make but one slight alteration in this assertion, namely, that the nearer we all approach to mathematics and *cosmical* physics, the nearer we should be to perfection.

L. A. BAUER

THE CARNEGIE INSTITUTION
OF WASHINGTON

CHARLES OTIS WHITMAN

PROFESSOR CHARLES OTIS WHITMAN, head of the department of zoology of the University of Chicago, died of pneumonia after a brief illness on December 6, 1910. He was born in Woodstock, Maine, December 14, 1842. He received the degree of A.B. from Bowdoin College in 1868, and A.M. in 1871. From

1869 to 1872 he was principal of Westford Academy and in 1872 was teacher in the English High School of Boston. A few years later he was studying zoology with Leuckart in the University of Leipzig and received the degree of doctor of philosophy from this university in 1878. From 1880-81 he was professor of zoology in the University of Tokio, and in 1882 we find him studying at the Zoological Station of Naples. From 1883-85 he was assistant in the Zoological Laboratory of Harvard University and was then appointed Director of the Allis Lake Laboratory at Milwaukee (1886-89). He was then called to the charge of the department of zoology of the newly founded Clark University, and in 1892 he became head of the department of zoology in another newly founded university, the University of Chicago, which position he held until his death, being thus associated with the whole of the formative period of this institution. He was the first director of the Marine Biological Laboratory, from 1888 to 1908, and established the policy of the institution. He was founder and also editor of the *Journal of Morphology*, the *Biological Bulletin* and the Woods Hole series of Biological Lectures. He was the chief organizer of the American Morphological Society, now the American Society of Zoologists, and was its president for the first four years. He was also a devoted teacher of advanced students many of whom now occupy important academic positions in this country. He was a member of many scientific academies and societies, and received the honorary degrees of LL.D. from Nebraska in 1894 and Biol.D. from Clark University in 1909. Among the subjects that occupied him during a life of intense activity in biological research were: the embryology, morphology and natural history of leeches, the morphology of the Dicyemidæ, the embryology of the bony fishes; evolution of color characters in pigeons; natural history of pigeons; hybridization and heredity in pigeons; and studies in animal behavior.

Professor Whitman's life was devoted entirely to scholarly ideals of biological research

which he sought to realize with rare singleness of purpose. Not only did he devote himself to personal research with extraordinary enthusiasm and thoroughness, but he had an almost prophetic comprehension of the ways and means for furthering biological investigation, and he was able to secure the cooperation of his colleagues in his enterprises by virtue of a personality that was both singularly winning and compelling. In 1887 he founded the *Journal of Morphology*, now in the twenty-second volume, for the publication of research in zoology, and established it at once on so high a plane that it took rank with the foremost journals of zoological research of the world. It has since served as model for newer research journals in America. In 1888 he was called to be director of the Marine Biological Laboratory of Woods Hole, then newly established, and presided over its fortunes for a period of twenty-one years, during which time it came to be the leading center of biological research in America with a unique and interesting form of organization described more particularly farther on. Before any one else in America, he also urged the need of the establishment of an experimental station for the study of problems of evolution, heredity and animal behavior, a "biological farm" as he preferred to call it, and although he was not successful himself in establishing such a station, others have since brought it about. In the later years of his life Professor Whitman's personal researches became continually more engrossing and he gradually relinquished his other undertakings into the hands of younger men.

Professor Whitman belonged to no narrow field of zoology. His scientific interests were broad and they were continually bringing him into contact with workers in other fields. He had a very deep interest in all the fundamental problems of biology and we thus find him forming close scientific association with workers in the fields of botany, physiology and psychology as well as in his own field of zoology.

In many respects the Marine Biological Laboratory constitutes Professor Whitman's

chief monument. Here his ideas had their fullest scope. His fundamental idea in the conduct of the laboratory was cooperation; and he succeeded in establishing what has well been called a marine university, in which the ownership and control as well as the conduct of affairs is vested in the body of active scientific investigators. The entire body of past and present investigators with few exceptions, constituting the corporation, is the court of last appeal; it elects the board of trustees mainly from its own membership, and the immediate control of laboratory affairs is carried out by the board through their appointive agents, the directors and members of the staff. The result has been the realization in our own time and country of the ancient ideal of the university, a republic of scholars.

Such an organization is exposed to dangers internal and external, and though both kinds appeared at various times Professor Whitman always refused to compromise any fragment of his fundamental idea. He was therefore often called an impractical idealist by men both within and without the organization. Idealist he was, whether impractical or not was none of his concern. He often seemed to be most resolute when he stood almost alone, as when a safe harbor of refuge for the laboratory appeared within the protecting breakwaters of an established and endowed institution, and nearly all were ready to put into port. Yet he preferred liberty and the storm, and all finally stood by him.

Professor Whitman instantly recognized creative ability in an investigator, and his appreciation was invariably hearty, and his support ever ready to the fullest extent. It is no accident that many of the important discoveries in biology in America during the last twenty years were made at Woods Hole. Professor Whitman had early recognized the ability of the workers in question, and had invited them to work at Woods Hole and secured their allegiance to the laboratory, and to himself; for his was a most magnetic personality. Thus he gradually attached to the interests of the laboratory an increasingly strong body of scientific investigators.

Professor Whitman's interest in the teaching side of his profession is fully demonstrated by his organization of teaching as a department coordinate with research in the Marine Biological Laboratory. He steadfastly resisted the influence of some of the investigators in favor of doing away with instruction at the laboratory. He held that teaching exerted an important reflex influence on the body of investigators. He enjoyed and valued the presence of the student element, for whom he had constant sympathy and towards whom he exhibited the utmost friendliness. It has resulted at Woods Hole that the institution, which was made by investigators, has aided in the making of many investigators. Surely no environment more favorable for awakening and stimulating scholarly ambition could be found.

Although Professor Whitman published relatively few papers he nevertheless occupied a commanding position in science. Some of the reasons have already been indicated. His "eye was single and his whole body was therefore full of light"; his devotion to scholarship was never open to the slightest shadow of suspicion. He was continuously engaged in his personal research which dealt with the most fundamental problems of biology, and he had accumulated vast stores of data, which we hoped he would live to publish himself. But apparently he could never satisfy himself with reference to the fundamental problems on which his mind was fixed; the grand consummation of his work had not come, and he could not reconcile himself to the publication of more or less fragmentary pieces of work. His published papers, mostly short, are models of condensed thought, written in a fine, polished, characteristic style. No less care was devoted to the form than to the substance, and some of his papers certainly will endure as classics of the biology of his time. His activities in connection with the *Journal of Morphology* and the Marine Biological Laboratory brought him into close personal relations with the leading biologists of his time, most of whom learned to value highly his

somewhat rarely and deliberately uttered expressions of opinion on scientific problems.

It was, therefore, not only his publications but also his work with his journal, his laboratory and his students, his constant helpful association with other workers and the example of his austere and studious life that brought him recognition. He never permitted himself to be distracted by the confusion of modern life, social or academic, nor diverted from his steadfast purpose by clamor for quick results.

It is impossible for us yet to measure justly the value of such a life to our community; it conveys a much-needed lesson of consecration to the ideals of scholarship; our appreciation of it will surely increase in proportion as time eliminates all the petty details that confuse the picture of a great man's life, and permits its essential nobility to shine forth undimmed.

F. R. L.

December 21, 1910

WITH the death of Charles Otis Whitman America has lost the third of her greatest scholars. Professor Whitman's name belongs with those of William James and Simon Newcomb, not only because of the profound influence he has exerted on the development of zoology in this country by means of his personality, by founding at Woods Hole a unique biological university and by the establishment of the *Journal of Morphology*, but also because of the strength of his character and the greatness of his achievements in science.

His scientific work marks him as a great master, for his finished, published papers are truly masterpieces both of content and expression. In addition to these he had accumulated by long, patient and untiring study an enormous mass of observations on the habits and behavior of pigeons, their phylogeny, inheritance, the origin of species and the progression of species by orthogenesis, independent of natural selection. The general results of this work he had presented from time to time in brief addresses and he was preparing for publication a full report of it, when he be-

came ill. Among the results of his scientific work none is more fundamental than his proof of the real course of descent of the pigeons. He showed that Darwin had been mistaken in believing the barred type of pigeon to be primitive. The evolution was in reality from the checkered to the barred type. This discovery led him to the evidence of orthogenetic development in the pigeons and filled in, provisionally at any rate, one of the most puzzling gaps left by Darwin in the problem of evolution. A correct understanding of the direction of evolution of the pigeons gave him, also, the key to the interpretation of the phenomena of inheritance, enabling him to escape the pitfalls which beset the steps of those who do not know the past history and direction of evolution of the forms with which they are working. In addition to this splendid and fundamental work there were, also, long years of study of the embryology and phylogeny of the leeches, the results of which were in part published in his papers on metamerism, the inadequacy of the cell theory of development, and embryology, but in large part remain unpublished, preserved in notes and exquisite drawings. It is probable that much of this work and that on the pigeons will be found in such form that it can be published. As a scientist, Professor Whitman was painstaking, self-critical, patient and profound.

It is not, however, of his work as a scientist upon which I wish to dwell, but rather to recall his personality that the memory of it may remain always with us. His white hair; his kindling, eager, but thoughtful eyes; his tender, gentle smile; his reticence of speech; his consideration for others; his generosity and courage; his hospitality and graciousness as a host; these endeared him to us all. We shall never forget his simple, unassuming, modest manner; his encouraging sympathy; his ripe and sane judgment. If when he was alone he lived simply, the absorbed student of science, when with his guests in his home he was the embodied spirit of hospitality.

His great influence as a teacher was due in part to his fine example and noble ideals, and

in part to his habit of picking out young men, who showed any love for science, inviting them to his home, drawing them out, encouraging them and giving them his friendship. Many of them he helped financially, and all of those fortunate enough to work near him owe him a debt of gratitude for his sympathy and inspiration. Probably no teacher in zoology since Louis Agassiz has exerted so great an influence on young men.

His uncompromising loyalty to principle and his high ideals of work and conduct were among his strongest characteristics. The Woods Hole Laboratory represented his ideal of a laboratory in its organization and spirit. Again and again he stood almost alone against his most intimate friends and associates who, frightened at the financial outlook, wished to sacrifice those ideals. He invariably prevailed in the long run and events have proved his judgment to have been sound. He was a rock upon which all plans which were not shaped in accordance with ideals but rather in accord with opportunity, were sooner or later wrecked. This loyalty to ideals was shown, also, in his struggle for a biological farm at the University of Chicago. Having outlined an ideal biological farm he refused firmly to give up any feature of it which was essential to that ideal. He preferred to wait until the ideal could be had, rather than to compromise on some less perfect scheme.

He was always loyal, also, to his ideals of science and no amount of criticism or pressure could induce him to publish one word until he was sure that word was the truth and nothing more or less.

He had also an uncompromising and outspoken hatred of shams and half-truths of all sorts. Unreliability in any particular he could never tolerate. He was slow to condemn any man, but once he had weighed him and found him wanting, he never afterwards trusted him. In common with many biologists he had no belief in a future life, but his own life demonstrated in the highest degree, how unnecessary such beliefs are to a truly noble soul.

If there was any one characteristic which

endeared him more than another to all in contact with him, it was his instinctive consideration for others and his warm sympathy. No matter how busy he was, he always welcomed one with a warm clasp of the hand and that charming, tender smile; no matter how long one stayed, it was always too soon to go; no matter how often one came, here was a friend who wished you to come more often. Those in trouble came to him. Every tie of affection, gratitude and respect bound us to him. Every meeting with him was a reinspiration in those splendid ideals of which his whole life was the expression.

We have lost a most loyal and affectionate friend, a great scientist and scholar, a truly noble and simple man.

ALBERT P. MATHEWS

SCIENTIFIC NOTES AND NEWS

At the Pittsburgh meeting, December 27-29, 1910, of the Geological Society of America the following officers were elected for the year 1911:

President—W. M. Davis, Cambridge, Mass.

First Vice-president—W. N. Rice, Middletown, Conn.

Second Vice-president—W. B. Scott, Princeton, N. J.

Secretary—Edmund Otis Hovey, New York City.

Treasurer—William Bullock Clark, Baltimore, Md.

Editor—Joseph Stanley-Brown, Cold Spring Harbor, N. Y.

Librarian—H. P. Cushing, Cleveland, Ohio.

Councilors (1911-13)—Heinrich Ries, Ithaca, N. Y., and A. H. Purdue, Fayetteville, Ark.

At the recent Pittsburgh meeting of the American Paleontological Society, Professor William B. Scott, of Princeton University, was elected president. The statement in regard to the presidency, taken from the daily papers and printed in the last issue of SCIENCE, was incorrect. Other officers of the society are as follows: *First Vice-president*, Arthur Hollick, New York City; *Second Vice-president*, W. D. Matthew, New York City; *Third Vice-president*, Stuart Weller, Chicago, Ill.; *Secretary*, R. S. Bassler, Wash-

ington, D. C.; *Treasurer*, Richard S. Lull, New Haven, Conn.; *Editor*, Charles R. Eastman, Cambridge, Mass. Correspondents were elected as follows: Professor G. Alfred Nathorst, Stockholm; Professor E. Koken, Tübingen; S. S. Buckman, England, and Professor Charles Déperet, France.

PROFESSOR RALPH S. TARR, of Cornell University, was chosen president of the Association of American Geographers at its recent meeting in Pittsburgh.

PROFESSOR L. B. MENDEL, of Yale University, was elected president of the Society of Biological Chemists at the New Haven meeting.

At the annual election of the American Philosophical Society held on January 6 the following officers were chosen for the ensuing year: *President*, William W. Keen; *Vice-presidents*, William B. Scott, Albert A. Michelson, Edward C. Pickering; *Secretaries*, I. Minis Hays, Arthur W. Goodspeed, James W. Holland, Amos P. Brown; *Curators*, Charles L. Doolittle, William P. Wilson, Leslie W. Miller; *Treasurer*, Henry La Barre Jayne; *Councilors* (to serve for three years), Henry F. Osborn, Joseph G. Rosengarten, Edward W. Morley, Henry H. Donaldson.

A MARBLE bust of President Emeritus Eliot, the work of Mr. Louis Parker, of New York, has been placed in the faculty room of Harvard University.

DR. S. WEIR MITCHELL, who has been a trustee of the University of Pennsylvania since 1875, has resigned.

THE Zoological Society of London has elected as corresponding members Mr. Theodore Roosevelt and Mr. W. H. Osgood; Mr. S. H. Scudder as foreign member.

DR. H. C. BUMPUS, director of the American Museum of Natural History, has been decorated by King Charles, of Roumania, with the grand cross of the commander of the order of the crown.

SIR T. CARLAW MARTIN, LL.D., editor of the *Dundee Advertiser*, has been appointed director of the Royal Scottish Museum, Edinburgh.

PROFESSOR ARTHUR H. BLANCHARD, of the department of civil engineering, Brown University, has recently been appointed expert and consulting engineer to the United States Office of Public Roads.

PROFESSOR M. V. O'SHEA, professor of education at the University of Wisconsin, has been appointed chairman of the American committee of the International Congress on Childhood and Youth. The next session of the congress will be held in the United States, probably at Washington in 1912.

ARTHUR R. CUSHNY, M.D., F.R.C.S., professor of pharmacology in the University of London, will deliver the first of the "Weir Mitchell Lectures" at the Weir Mitchell Hall in the College of Physicians, Philadelphia, on January 17. His subject will be "Heart Irregularity from Auricular Fibrillation."

DR. GÜNTHER JACOBY, privatdocent at the University of Griefswald, and research fellow in philosophy at Harvard University, is giving a course of seven lectures on "Schopenhauer," beginning January 6. The lectures are open to members of Harvard University.

THE municipality of Dôle, Jura, has just voted to buy and preserve the house where Pasteur, on December 27, 1822, was born.

THE *Journal* of the American Medical Association states that as a permanent honor to its founder, who was also for many years its honorary president, the Verein für innere Medizin und Kinderheilkunde of Berlin has resolved, on motion of Professor Schwalbe, to establish a Leyden lectureship, the lecture to be given annually at the first session of the winter semester, by a speaker selected by the board of directors. This arrangement, which follows the English custom, is the first of the kind made in Germany. A large fee will be paid the lecturer, derived from the interest of the fund of \$14,000, established on the seventieth birthday of von Leyden. The rest of the interest on the fund is to be devoted to scientific research under the influence of the society for internal medicine.

THE death is announced at Cincinnati at the age of eighty-eight years of Mr. Benn

Pittman, who with his brother, Sir Isaac Pittman, developed the system of stenography which bears their name, and is also known for his inventions in connection with electrotyping.

THE Sarah Berliner research fellowship for women will be awarded for the second time this year. This fellowship, of the value of twelve hundred dollars, is available for study and research in this country and in Europe. It is open to women holding the degree of doctor of philosophy, or to those similarly equipped for the work of further research; it will be awarded only to those who give promise of distinction in the subject to which they are devoting themselves. Applications must be in the hands of the chairman of the committee, Mrs. Christine Ladd Franklin, 527 Cathedral Parkway, New York, by February 1. This fellowship was awarded two years ago (it is given only every two years) to Miss Caroline McGill, Ph.D., who was a member of the teaching staff of the University of Missouri. Miss McGill has spent a year in Europe, chiefly at the Naples Zoological Station.

DR. A. D. GABAY, of New York City, has presented to the American Museum of Natural History a collection of ground and polished shells from California and Japan. These specimens with their convolutions and superb nacre make objects of great beauty. They will be installed in certain sections of the hall of mollusca, illustrating the economic and ornamental uses of shells. The museum has also received, as a gift from Mr. D. C. Staples, a collection of archeological and ethnological material which comes from the provinces of Esmeraldas and Manabi in the extreme northern part of Colombia, South America.

ACCORDING to *Nature* a new zoological garden in course of construction by Mr. Carl Hagenbeck in the grounds of the Villa Borghese, Rome, was expected to be opened on January 1. The grounds, which comprise twenty-eight acres, lie outside the old walls to the northward of the city, and it is stated

that more than \$200,000 has been already spent on them, while the animals, some 1,400 in number, represent \$50,000. As at Stellingen, cages have been to a great extent dispensed with, deep ditches and scarped cliffs serving to confine the animals, which thus appear to be at liberty.

CONSTRUCTION has begun upon the new Boston Psychopathic Hospital, which has been planned by the Board of Insanity, in accordance with an act of legislature, to receive, observe and treat the acute mental patients of the metropolitan district in Massachusetts. The hospital will be operated by the Boston State Hospital trustees, who have appointed Dr. E. E. Southard director. The institution is planned to contain one hundred beds and embodies the main features of the modern general hospital as well as special therapeutic features appropriate to mental disease. A wide scope is expected for the out-patient and social-service departments. Other districts in the state may in time develop similar psychopathic hospital units, which will take their place alongside the hospitals, asylums and colonies as special clearing-houses and therapeutic establishments for the acute cases of mental disease in each district. In the psychopathic hospitals emphasis will naturally be laid on investigations, both psychic and somatic, into the nature and causes of mental disease.

A BILL to make Paris official time coincide with Greenwich time was presented, as we learn from *Nature*, to the French senate on December 21. The bill was passed by the chamber of deputies several years ago, and has been approved by the senate committee and by the cabinet, so that in all probability it will become law. Paris time is 9m. 21s. ahead of Greenwich time; and upon the day prescribed by the law, the clocks indicating official time in France will be put back by that amount. By the adoption of the change, France will be brought into the international system of standard time reckoning which is now followed in the United States and in most civilized countries. On this system, the hour of each successive fifteen degrees of

longitude, reckoning from the Greenwich meridian, is used for the standard time; hence the difference in time in passing from one zone to another is always an exact number of hours.

At a meeting of the Paris Academy of Medicine held on December 13 the list of the prizes awarded during 1910 was read out by the secretary, M. Weiss. According to the *British Medical Journal* they include the following: The François-Joseph Audiffred prize (\$4,800) was not awarded, but sums of \$200 were granted to MM. Xavier Delore and André Chalié, of Lyons, for their work on tuberculosis of bone, by way of encouragement; in the same way a sum of \$100 was given to M. Jules Lemaire, of Paris, for his researches on the skin reaction to tuberculin, especially in children. The Baillarger prize (\$400) was awarded to Dr. Gabriel Dautre-bente, of Tours, for his work on the medical organization of lunatic asylums. The Prix Barbier (\$400) was divided between Dr. Maire, of Villejuif, for a memoir on the colonization of the epileptics of the Seine Department, and Dr. E. Sacquépés, of the Val-de-Grâce Military Hospital, for his notes on paratyphoid infection. The Boggio prize (\$875) was awarded to Dr. Rappin, of Nantes, for his researches on a method of vaccination and immunization against tuberculosis. The Adrien Buisson prize (\$2,000) was awarded to Drs. de Beurmann and Gougerot, of Paris, for their work on sporotrichosis; the Campbell-Dupieris prize (\$450), to Dr. M. Jungano, of Naples, for a memoir on the flora of the urinary apparatus, normal and pathological; the Théodore Herpin prize (\$600), to Dr. Félix Rose, of Paris, for a work on apraxia; the Huguier prize (\$600), to Dr. Salva Mercadé, of Paris, for an essay on cysts and abscesses of the uterus; the Laborie prize (\$1,000), to Dr. H. Dominici, of Paris, for his work on the treatment of malignant tumors with radium; the Louis prize (\$600), to MM. P. Emile Weil, F. Lévy, and G. Boyé, for a paper on internal hæmostatic methods; the Meynot prize (\$500), to Dr. Louis Balden-

week, of Paris, for an anatomical and clinical study of the relations between the internal ear and the point of the petrous bone, the Gasserian ganglion, and the sixth pair of cranial nerves. The Orfila prize (\$1,200), for the best essay on the purification of town water after use, and of polluted factory waters, was divided between MM. Edmond Rolants, E. Boullanger, Léon Massol and Félix Constant. The Perron prize (\$750) was divided between M. Albert Frouin, of Paris (on the possibility of keeping alive animals after complete removal of the thyroid apparatus, by the addition of calcium salts or magnesium to their food); M. Gernaro Sisto, of Buenos Aires (the cry of sucklings and hereditary syphilis); and MM. Noël Fiessinger and Pierre Louis Marie, of Paris (notes relating to the protease and lipase of leucocytes). The Saintour prize (\$875) was awarded to M. Gabriel Petit, of Alfort, for a contribution to pathological anatomy and pathogeny of tumors of the breast; the Tarnier prize (\$875) to M. André Delmer, for a contribution to the study of auto-intoxications of pregnant women and female bovine animals.

THE statistics of coal production as collected jointly by the United States Geological Survey and the Bureau of the Census show that in 1909 the output amounted to 459,209,073 short tons. Compared with the record for 1908, when the production amounted to 415,842,698 short tons, the record for 1909 shows an increase of 44,039,650 short tons, or 10 per cent. All of the gain was in the production of bituminous coal, which increased from 332,573,944 short tons in 1908 to 378,551,024 short tons in 1909—a gain of 45,977,080 short tons. The production of anthracite in Pennsylvania decreased from 74,347,102 long tons (equivalent to 83,268,754 short tons) in 1908 to 72,015,222 long tons (equivalent to 80,658,049 short tons) in 1909. Pennsylvania made the largest increase in the production of bituminous coal, showing a gain of 20,666,288 short tons, from 117,179,527 short tons in 1908 to 137,845,815 tons in 1909. West Virginia for the second time in its his-

tory exceeded Illinois, and became the second state in the production of coal, the former having an output in 1909 of 51,446,010 short tons, and the latter an output of 50,970,364 short tons. West Virginia's production increased 9,548,167 short tons over 1908. The output in Illinois, which stood third in rank, increased only 3,310,674. Ohio retained its position as fourth in rank with a production in 1909 of 27,919,891 short tons, against 26,270,639 in 1908. Indiana, which in 1908 supplanted Alabama as fifth in rank, strengthened its position in 1909 by an increase of 2,566,809 tons, from 12,314,890 tons in 1908 to 14,881,699 tons in 1909, while Alabama gained 2,099,317 tons, from 11,604,593 tons to 13,703,910 tons. Other significant increases were in Colorado, 1,087,773 tons; Wyoming, 890,995 tons; Kansas, 734,270 tons; Montana, 640,082 tons; Iowa, 594,052 tons, and Washington, 551,463 tons. Georgia, Idaho, Maryland, Michigan, Missouri and Texas showed a smaller production in 1909 than in 1908, the total decreases amounting to about 750,000 tons.

Nature quotes from the *Aeronautical Journal* for October the announcement that the council of the Aeronautical Society had conferred the gold medal of the society on Mr. Octave Chanute, consulting engineer, of Chicago, shortly before his death. Born in Paris in 1832, Chanute trained as an engineer in America, where his professional duties involved the construction of numerous railways and bridges, including consultative duties connected with the New York elevated railway; wood preservation was also his specialty. From 1874 onwards Chanute became interested in the problem of aviation, and not only did he make numerous experiments with models, but shortly after, or perhaps simultaneously with, Lilienthal and Pilcher's experiments in Europe Chanute took up the practical realization of gliding flight in America in collaboration with Mr. Herring and Mr. Avery. A large number of glides were made with different types of glider, commencing with a model based on the descriptions of Le Bris's historic "Albatross," and including

gliders with a large number of superposed planes, but the type finally adopted was a bi-plane glider furnished with a smallish balancing tail. Although balance was, as a rule, maintained by moving the body, Chanute embodied in his apparatus the principle of a flexible framework, which thus paved the way for the Wright Brothers' "warping" devices and similar arrangements for the recovery of balance and counteraction of instability, which form such a noteworthy feature of modern aeroplanes. The glides made with his machines were remarkably successful, and, the practising grounds being among sand dunes, no fatalities ensued. Chanute was the author of a number of papers and reviews dealing with the flight problem, and the Wright Brothers, the late Captain Ferber, and numerous other aviators were indebted to him for much valuable assistance.

THE following statement, concerning the University of Wisconsin, appeared in the republican party platform of that state:

We are proud of the high eminence attained by our state university. We attribute its advancement both to the able and courageous guidance of its president and faculty and to the progressive and enlightened character of the citizenship that sustains it. We commend its work, illustrated by what has been accomplished in agricultural and dairy affairs, conserving our natural resources which have effected a saving of millions of dollars annually to the people of our state. We also commend its investigations for the improvement of the relations of men to one another. We regard the university as the people's servant, carrying knowledge and assistance to the homes and farms and workshops, and inspiring the youth toward individual achievement and good citizenship. We recognize that its service to the state, through investigations in agriculture, industrial and social institutions, depends upon its freedom to find the truth and make it known, and we pledge the republican party to the policy of academic freedom so well expressed by the board of regents in 1894, when they declared: "Whatever may be the limitations which trammel inquiry elsewhere, we believe that the great State University of Wisconsin should ever encourage that continual and fearless sifting and winnowing by which alone the truth can be found."

UNIVERSITY AND EDUCATIONAL NEWS

AN alumnus, who does not wish his name disclosed, has given \$100,000 to the University of Pennsylvania for the endowment of a chair of physiological chemistry. It will be known as the "Benjamin Rush chair of physiological chemistry." Dr. Alonzo E. Taylor, formerly of the University of California, will be the first occupant of the chair.

THE University of Vermont has received \$67,965 from the Rockefeller Foundation, representing the first instalment of a gift of \$100,000 made to the university on condition that an additional \$400,000 be raised. The \$400,000 has now been subscribed and the amount \$271,000 has been collected. The half million dollars is to be added to the endowment fund for the general uses of the university.

MR. WILLIAM BLODGETT has given to Columbia University two farms near Fishkill, N. Y., to be used in connection with the work in agriculture.

THE mining engineering building of the University of North Dakota is being enlarged and the interior remodeled in response to an imperative demand for more room. The roof has been raised, materially adding to the light, floor space and utility of the technical museum. Adjoining the museum, which is in the center of the building, there is to be at one end a large preparation room for the curator and at the other a mineral stock room. The laboratories on the first and second floors have been readjusted to provide better facilities for the classes in analytical chemistry and metallurgy as well as for research work in ore treatment, coals and clays. The newly-established ceramic department is being equipped with general clay working and pottery machinery.

COLUMBIA UNIVERSITY, according to the official catalogue which has just been published, has this year a registration of 7,429 students. The vast majority of these are in the graduate and professional faculties, the undergraduate and scientific departments having a total registration of 1,456. Nearly every department of the university shows an increase of

from 5 to 20 per cent. The academic department has 732 students as compared with 636 a year ago. The medical school, which for the first time required more than a high-school training for admission, has practically the same number of students as it had a year ago, 316 men fulfilling the requirement of two years' college work having entered the school. The number of officers and instructors is the largest in the history of the university, numbering 761, including the emeritus professors, of whom there are 16. The newly-appointed professors include: William B. Fite and Herbert E. Hawks, in the department of mathematics; Walter Irvine Slichter, electrical engineering; George V. Wendell, physics, and Milton C. Whitaker, industrial chemistry.

DR. EDGAR F. SMITH, professor of chemistry in the University of Pennsylvania, became provost on New Year's Day, succeeding Dr. Charles C. Harrison, who had held this office for seventeen years. Dr. Smith will continue to lecture on chemistry.

PROFESSOR G. R. THOMPSON, professor of mining, University of Leeds, has been appointed professor of mining at the South African School of Mines and Technology, Johannesburg, and principal of the college.

PROFESSOR GUIGNARD, who has served for fifteen years as director of the Paris School of Pharmacy, has resigned his appointment and is succeeded by Mr. Henry Gautier, professor of mineral chemistry at the school.

THE professors of the Paris medical college have nominated Dr. Dejerine, professor of medical pathology, to the clinical chair of diseases of the nervous system at the Salpêtrière. This position, once held by Charcot, was recently occupied by Professor Raymond, who died last September.

DISCUSSION AND CORRESPONDENCE

INORGANIC NOMENCLATURE

IN the issue of SCIENCE for December 9 appeared an article on the nomenclature of the acid phosphates. The author, R. E. B. McKenney, pointed out the difficulty of identify-

ing these from the trade names, and suggested more exact names as primary, secondary and tertiary or, better, mono-, di- and tri-potassium phosphates. While the change would be a step in the right direction it fails with salts of the polyvalent metals; for the mono-calcium salt would correspond to the di-potassium and thus the confusion would be perpetuated. It appears to the writer that a more scientific method would be to indicate the number of replaceable hydrogen atoms (per molecule of acid) present in the salt. Thus K_2HPO_4 and $CaHPO_4$ would be named mono-hydrogen phosphates while KH_2PO_4 and $CaH_2(PO_4)_2$ would be the di-hydrogen phosphates. The normal phosphates could then be designated as such or simply as phosphates.

In this connection I would call the attention of chemists, manufacturers and printers of chemical names to the need of a thorough revision of inorganic nomenclature. It is still common to hear and read the names potassic hydrate for potassium hydroxide and sodic carbon for sodium carbonate; the hydrogen (acid) carbonates are called bicarbonates because in making them two equivalents of the acid are required for each equivalent of the base. But modern chemistry is founded on molecular rather than equivalent quantities and a bicarbonate should mean, therefore, two carbonate (CO_3) radicals in the molecule of the salt. Besides, the bichromates are not acid salts at all in the sense of containing replaceable hydrogen atoms. Likewise the percarbonates, persulphates and permanganates do not follow the nomenclature of the perchlorates, perbromates and periodates. Also the dioxides and peroxides are named with no discrimination as to differences in constitution.

Has not the time come for scientific men to be exact and scientific in the matter of chemical nomenclature, and to demand of manufacturers the use of names which shall indicate the composition of the material designated? And would it not be well for section C of the American Association, or the American Chemical Society, to appoint a permanent committee on inorganic nomenclature to

the end that all chemical names shall be understood, because they indicate exact composition?

J. H. RANSOM

PURDUE UNIVERSITY,
LAFAYETTE, IND.

COASTAL SUBSIDENCE IN MASSACHUSETTS

TO THE EDITOR OF SCIENCE: While Professor D. W. Johnson has clearly shown in the November 18 issue of SCIENCE that there are certain factors which produce fictitious appearances of coastal subsidence, chief of which is the irregular height of the tidal wave due to the varying character of the shore, there are a number of marks of subsidence on the Massachusetts coast which it is not probable can be so explained. For example, near Misery Island, Beverly, stumps of forest trees appear in place at a depth of twelve to fourteen feet below low tide.

The striking example given by Professor Johnson of the fictitious appearance of coastal subsidence at Scituate proves also, it seems to me, that subsidence has really been going on. The very fact that the level of the inside marsh was several feet below the outside level of high tide showed how much the land had sunk since the mouth of the North River had been nearly closed. A very similar state of affairs exists in the region of the Norfolk Broads in the eastern part of England. Here, in the same way, the land is slowly sinking, but, owing to the silting up of the mouths of the Yare and the Bure rivers, aided by dyking, the tides have been largely excluded, the marsh has become fresh and has so long ceased to build up that it is below the level of high water outside, and there is danger of the sea breaking through the sand dunes and, as at Scituate, drowning out the region.

CHARLES W. TOWNSEND

BOSTON,
December 2, 1910

CALENDAR REFORM

TO THE EDITOR OF SCIENCE: I read with interest Professor Chamberlin's suggestions for the reform of the calendar, in the current number of SCIENCE, November 25. It happens

that I had thought of a scheme the same as that of Professor Chamberlin in all essential features, but was led to abandon it before publication because I considered that its disadvantages outweighed the advantages.

The advantages of the seasonal division are very slight. The scheme would suit conditions here as well as the present arrangement. In Great Britain, however, the winter begins in November, spring in February, etc. Hence Professor Chamberlin's arrangement with winter beginning in January would not suit conditions and would not be accepted. The earth receives the smallest amount of heat and light at the winter solstice, and neglecting lag this should be midwinter. To call it the beginning of winter as astronomers do, is to allow 45 days lag. To call January 1 the beginning seems to be allowing 55 days lag, not 10 as stated by Professor Chamberlin. This lag varies so much in length with latitude and local conditions that it does not appear that any division of the months into seasons will be universally satisfactory.

The desirability of a year divisible into quarters is unquestioned. But let us see the disadvantages of the scheme. A man who pays rent, for instance, would find his rent due in the first quarter on the first of the month, say. It would be due the Monday of Easter week, on the twenty-second of the month in the second quarter, fifteenth in the third and the eighth in the fourth. Likewise with monthly salaries and, in fact, all business done by the month. A promissory note dated February 15 due in two months would be due April 8, but if due in one month, March 15, or if due in nine months it would be due October 22. If due in eight months, on the first day of Gregorian week. Likewise, in finding the interval in days between two days we should always need to be on guard against omitting or including wrongly one of these weeks. This problem is a very common one in business. Since the suggestion has been made, there will be no difficulty in multiplying these illustrations indefinitely. When we compare this complexity with the simplicity of the same problems in the regular 13 months of 28

days we see how much is lost. These same objections of course apply, but with less force, to the scheme of Reininghaus, July 29.

Professor Chamberlin's plan would cause the month to be abandoned as a unit of time for business, and force us to use the week or day.

It is true that the same objections may be raised to the 13-month system if we use a quarter as a unit, that is, a quarter from February 15 would be May 22, two quarters, August 1 (assuming the extra month in the middle of the year). But withal this is simpler. Moreover, when we compare the amount of business done by the quarter with that done by the month and day we see which should have the greater consideration in constructing a simple calendar.

I feel sure that these objections could not have occurred to Professor Chamberlin.

SAMUEL G. BARTON

CLARKSON SCHOOL OF TECHNOLOGY,
November 29, 1910

INTERNATIONAL CONGRESSES

TO THE EDITOR OF SCIENCE: At the request of the Swedish geologists the International Geological Congress took place this year instead of 1909. This year was also that in which the International Zoological Congress naturally fell to be held. Since, for the convenience of university workers, these congresses are usually held at the same time of year, and since they, with their excursions, now extend over a considerable period, especially in the case of the Geological Congress, it was almost inevitable that the times of the meetings should clash. This may not affect a large number of participants, but it is rather hard on paleontologists, whose interests lie in both camps, and who, even with the aid of the aeroplane, can not be in two places at once. I should not trouble you with a complaint about what appeared to be inevitable this year, were there not signs of the same difficulty recurring in perpetuity, unless a protest is at once raised. As a matter of fact, the committee of "Paleontologia Universalis," when it met at Stockholm, forwarded to the council of the congress a request that

this interference should be avoided in future. That protest seems to have been without result. If so, in 1913 the paleontologist will again find himself summoned either by duty or desire to opposite quarters of the globe.

F. A. BATHER

SCIENTIFIC BOOKS

Monograph of the Okapi. By Sir E. RAY LANKESTER, K.C.B., M.A., D.Sc., F.R.S., etc. Atlas (of 48 plates). London, printed by order of the Trustees of the British Museum. 1910. 4to, pp. i-viii, plates 1-48.

Few events of recent years have aroused the interest of naturalists so much as the discovery of the okapi. It was sufficiently surprising that so large and strikingly marked an animal should have remained undiscovered for so many years; that it should prove to be related to a group now extinct increased the interest in the okapi and the known facts relating to it were promptly given in papers of scientific or popular interest, and more comprehensive memoirs were planned by those fortunate enough to be in the way of securing material. Among them was the present monograph, commenced by E. Ray Lankester while he was director of the British Museum and which having been delayed by many causes is a monograph in name only. It consists of 48 plates without text and it is stated in the preface that it is doubtful if the accompanying text will be issued, the need for any having been lessened by the appearance of Fraipont's monograph in 1907, and de Rothschilds and Neuville's paper during the present year, 1910. Fraipont's memoir, by the way, was begun by Forsyth Major, whose interest seems to have flagged after having had a number of illustrations prepared. The plates in Lankester's monograph comprise dorsal, lateral and palatal views of various skulls, drawn on a liberal scale, one third to one half natural size, and these are sufficient to afford good terms of comparison with other material. There are also views of the entire animal including one of a living calf, and plates illustrating variations in the vertebrae. As the explanations of the plates are very full a

pretty clear idea may be obtained of the character of the okapi itself, the great lack being detailed comparison of the okapi with other ungulates, living and extinct, and consequently, the absence of information regarding the relationships of the animal. A large number of illustrations are devoted to variations in the striping of the fore and hind legs, practically no two animals being alike in this particular. Some of these figures are from mounted specimens, and some from bandoliers made of okapi skin, including the first two obtained by Sir Harry Johnston, which Dr. Selater took to be from a zebra and in this belief described the animal as *Equus johnstoni*, on February 5, 1901, the generic name *Okapia* being given by Lankester later in the same year. *Okapia liebrechtsi* was described by Forsyth Major in 1902 and subsequently Lankester based a third species, *O. erichsoni*, on a peculiarity shown in the frontal hair whorls of an individual. There is, however, little doubt that there is but a single valid species.

It was a theory of Professor Marsh that good illustrations were really more important than text, since they showed facts that might be used by any one while the text would consist naturally more or less of the opinions of the writer. From this viewpoint the volume under consideration will be appreciated by all. It is also valuable as a study in individual variation, no two specimens of the okapi being quite alike either in external appearance or internal structure. And while Lankester qualifies his remarks on these points by saying that he has not had the opportunity of examining a similar amount of material of any other species of large wild animal there can be little doubt but what the okapi is really exceptional in the amount of individual variation it presents.

F. A. LUCAS

Reproduction artificielle de minéraux au XIXe siècle. By P. N. TCHIRWINSKY. Kief, 1903-1906. 8vo. Pp. lxxxviii + 638; 117 figures and 11 portraits.

A very comprehensive work on the artificial

production of minerals has recently been published in Russia by Professor Tchirwinsky. The work contains 177 figures of various crystals, some fifty of which were produced by the author himself, and also eleven portraits of scientists who have worked on synthetical minerals.

While covering the same ground as the earlier treatises on the subject by Fuchs (1872), Fouqué and Michel Lévy (1882), Bourgeois (1882) and Meunier (1884), as well as the chapters devoted to this subject in the works on mineralogy by Doelter (1890) and Brauns (1896), the writer has not only added a very complete record of the rich and important results of scientific research in this department during the last two decades of the past century, but has revised and rearranged the earlier material, and corrected several errors in the references. The critical remarks with which he accompanies his résumés are to a considerable extent based upon his own experiments.

The work falls into two parts, a general and a special part. At the outset the writer explains that he uses the term "artificially produced minerals" only in regard to those which are produced in the laboratory, and not in reference to such as may be fortuitously produced, as for example, the diamonds which have been found in steel, or minerals formed upon metal ornaments, etc., that have been long buried (pp. 13-15). In this connection the author cites the words of St. Meunier, that the convalescent who two thousand years ago cast a coin into a mineral spring whose waters had cured him, little knew that he was initiating a geological experiment.¹

The writer then proceeds to describe the more important kinds of apparatus employed in the laboratories for the artificial production of minerals; many of these are figured (pp. 15-24). He next passes to the consideration of the methods used for measuring artificial crystals (pp. 25-27). The fact that in a large number of cases these crystals are exceedingly small and can only be viewed through the

¹ Page 14, note: St. Meunier, "Méthodes de synthèse en minéralogie," Paris, 1891, p. 55.

microscope, makes it very difficult to measure them accurately and to determine their exact form. As the study of artificially produced minerals would be greatly facilitated by having an approximately complete collection in one place, the author expresses the wish that specimens of such minerals produced in various countries might be sent to the Société Mineralogique de France, in Paris; these, added to the large number of such minerals now in the Collège de France, etc., would make an exceptionally complete collection. An atlas of colored plates figuring the most important of them might then be issued by the French society, and this would serve to supply the lack of such material in many collections (pp. 27, 28).

The aims of mineral synthesis are then presented at some length (pp. 28-124). The light thus thrown upon the question of the natural formation of minerals is noted in the case of metalliferous deposits (pp. 30-33), dolomites (pp. 33-37), contact minerals (pp. 37-40), the formation of the diamond (pp. 43, 44), etc. This is followed by sections treating of the physical and chemical conditions influencing the form of crystallization assumed by various minerals and the order of their production, and also of their systematic classification, as explained or furthered by the results attained in artificial reproduction (pp. 49-119). It would be impossible, within the limits of this article, to do more than note the convincing demonstration of the great service rendered by the synthetic method in the solution of many difficult problems. Several mineral forms have been produced in this way in a purer state than that in which they naturally occur; in some instances forms not yet discovered have been produced, thus serving to fill up gaps in the different classes. In other cases where it is difficult or impossible to make an accurate analysis of the natural specimens, the synthetic products have supplied this deficiency, as in the case of the chalcocite from Argentina which was reproduced by C. Fridel and E. Sarradin in 1881 (p. 104). A very full list of the spinel crystals obtained by E. Ebelman is given (pp. 78-81).

While the scientific value of these artificially produced minerals can scarcely be overestimated, their practical value is very slight (p. 120). As the author notes, only the ruby has been reproduced in a form and size that renders the specimens to a great extent the same as the natural stones, and yet even in this case—apart from the fact that they are not products of nature, but of art—a careful examination reveals certain peculiarities, due to the method of production, which differentiate them from the natural rubies.

In the special part of the work (pp. 127-496) the very rich and complete material has been arranged in approximately chronological order, all the minerals produced by a given experimenter being grouped together under his name. This arrangement has its advantages, although it obliges the reader to seek in different parts of the book for information regarding any one mineral. This search is, however, facilitated by very complete indexes. A supplement (pp. 497-638) contains material omitted for one reason or another from the main work; here the arrangement is according to mineralogical classification.

Tschirwinsky has never been sympathetic with Moissan at any time or in this work. He has said, for excellent reasons.

The volume contains nine excellent portraits, the list of which is here added.

Eilhard Mitscherlich. Professor of chemistry in the Berlin University; member of the Berlin Academy of Sciences; d. 1863.

Henri Sainte-Claire Deville. Professor of chemistry in the École Normale and in the Sorbonne; member of the Académie des Sciences; d. 1881.

L. Troost. Professor of chemistry in the Sorbonne; member of the Académie des Sciences.

F. A. Fouqué. Professor of the natural history of inorganic bodies in the Collège de France; member of the Académie des Sciences. Paris.

A. Michel Lévy. Member of the institut; general inspector of mines. Paris.

Charles Friedel. Professor of mineralogy and of organic chemistry; d. 1900. Paris.

Etienne Stanislas Meunier. Doctor of Sciences; laureate of the institut. Paris.

Constantine Demetrius Chroustchhoff. Professor of mineralogy, crystallography and petrography in the St. Petersburg Academy of Medicine. St. Petersburg.

A. B. Fr. af Schultén. Professor of chemistry in the Alexander University at Helsingfors.

SCIENTIFIC JOURNALS AND ARTICLES

THE December number (volume 17, number 3) of the *Bulletin of the American Mathematical Society* contains the following articles: Report of the September meeting of the San Francisco Section, by C. A. Noble; "A new proof of the theorem of Weierstrass concerning the factorization of a power series," by W. D. MacMillan; Review of Kowalewski's *Determinantentheorie*, by Maxime Bôcher; Review of Wright's *Invariants of Quadratic Differential Forms*, by L. P. Eisenhart; Review of Volume 4 of Sturm's *Geometrische Verwandtschaften*, by Virgil Snyder; "Notes"; "New Publications."

The January number of the *Bulletin* contains: Report of the October meeting of the Society, by F. N. Cole; Report of the Königsberg meeting of the *Deutsche Mathematiker-Vereinigung*; "On the saddlepoint in the theory of maxima and minima and in the calculus of variations," by R. G. D. Richardson; "Note on identities connecting certain integrals," by Louis Ingold; Review of Poincaré's *Göttingen Lectures*, by G. D. Birkhoff; Review of Lorentz's *Theory of Electrons* and of Wien's *Elektronen*, by E. B. Wilson; "Shorter notices": Lilienthal's *Differentialgeometrie*, Volume 1, by E. J. Wilczynski; Boehm's *Elliptische Funktionen*, Part 1, by L. W. Dowling; Dingeldey's *Sammlung von Aufgaben zur Anwendung der Differential- und Integralrechnung*, by E. W. Ponzer; Murray's *Calculus*, by W. B. Carver; Crabtree's *Theory of Spinning Tops and Gyroscopic Motion*, by E. W. Brown; Loney's *Dynamics of a Particle and of Rigid Bodies*, by W. R. Longley; "Notes"; "New Publications."

The *Journal of Experimental Medicine* begins its thirteenth volume with the announcement that it will hereafter be issued once a

month instead of once in two months as heretofore. Two volumes will thus be issued each year. No change is made in the price of subscription. Dr. Benjamin T. Terry takes the place of Dr. Eugene L. Opie as the associate of Dr. Simon Flexner in the editorial control of the journal.

SPECIAL ARTICLES

VISUAL SENSATIONS FROM THE ALTERNATING MAGNETIC FIELD¹

THE experiments reported by S. P. Thompson in the *Proceedings of the Royal Society*, B, 82 (557), pp. 396 ff., are of great importance, especially in view of the negative results which have been obtained in the several earlier attempts to arouse sensations by subjecting the head to the influence of a magnetic field. Previous experimenters seem, however, to have used direct current, while Thompson used alternating current.

Thompson obtained his magnetic field from a coil of 32 turns of stranded copper conductor of .2 square inch equivalent cross section, the coil having an internal diameter of nine inches and a length of eight inches. This coil was supplied with 50-cycle alternating current, the maximal amperage being 180. The subject's head was inserted in the coil, and under these conditions Thompson and several others were able to obtain flickering light sensations which were especially conspicuous in the peripheral part of the visual field. The flicker was noticed even when the eyes were open. Certain subjects reported sensations of taste also.

It occurred to me on reading Thompson's report that the visual phenomenon might well be due to idio-retinal light, under the suggestion of the hum of the coil due to the alternating current, and as Thompson mentions no specific checks or precautions in his procedure, it seemed worth while to repeat the ex-

¹I am indebted to the persons mentioned in this paper for their interest and participation in the experiments, and especially to Professor J. B. Whitehead and Mr. Henry C. Louis, without whose cooperation the experiments would have been impossible.

periment. Professor Whitehead readily agreed to cooperate with me, and the first tests were made in his laboratory and under his personal supervision.

The coil used had 27 turns of a cable consisting of 37 copper wires (each .082 inch in diameter) equivalent to 250,000 circular mils. The coil was approximately 8 inches long, and elliptical in cross section, the internal diameters being 10.5 inches and 9 inches. With this coil no part of the subject's head or face touched the internal surface; a condition which we could not always attain with a coil of circular cross section and 9 inches internal diameter, which we first tried. The coil was suspended from the ceiling by ropes, so that the subject could sit in a chair with his head inside the coil. The transformer available forced approximately 200 amperes of 60-cycle A.C. through the coil, the potential drop between coil terminals being slightly over 12 volts. This gave a field of 5,400 ampere turns, against 5,760 maximal in Thompson's experiment.

On first trial I distinctly perceived the flicker. Dr. Anderson, Dr. Cowles, Dr. Essick and a student also perceived it on first trial. Dr. Watson was uncertain on first trial, but on second trial perceived the flicker, although not very distinctly until after several trials. Dr. Jennings, Dr. Whitehead and several others perceived absolutely nothing, even after careful trials. It still seemed to me possible that idio-retinal light and suggestion were at the bottom of the phenomenon and therefore Dr. Watson and I carried out some careful tests in which suggestion was excluded to the fullest possible extent, which tests showed conclusively that my suspicion was unfounded. In these tests the transformer rested on a table close beside the coil, so that the loud noise of the former completely drowned the hum of the latter. The current could be switched off the coil, and on resistance carrying practically the same amperage as the coil, so that in either case the transformer noise was the same. A telephone receiver connected with the transformer was hung on the coil, emitting a

loud noise whether the current was on the coil or on the resistance. For further precaution the subject's ears were plugged up as well as was possible. Under these conditions, where there was absolutely no way of telling by the sound whether the current was on or off the coil, each of us was able to identify the flicker with absolute precision.

Several subjects noticed a twitching of the eyelids, when the head was in the coil. This was noticed especially by two of the subjects who were unable to perceive the flicker, and who thought it probable that the muscular sensations were at the base of the phenomenon. They were asked to report on the twitching, while the current was being turned now on the coil, now on the resistance, and it was found that the twitching occurred just as strongly when there was no current on the coil as when there was current.

Those who perceived the flicker found it becoming less distinct after a minute or even less of stimulation, and found it restored by a few minutes' rest.

The flicker was best perceived with the eyes closed or with the room darkened, but was noticeable with the eyes open if the room was not too brightly lighted. The interior of the coil furnished a fairly dark background.

I made tests with both positive and negative after-images but could not find that the flicker affected them in any way. The flicker was strongest in the peripheral visual field, and possibly did not affect to any considerable degree the central portion of the field, in which were the after-images.

It was clear, as a result of these tests, that the phenomenon was really a matter of visual sensation, and that we were dealing with threshold values; it needed only higher intensity to make the flicker visible to all subjects. Further it seemed to me strongly indicated that current of less frequency would give more intense flicker. Mr. A. E. Loizeau, of the Consolidated Gas, Electric Light and Power Company, kindly offered us the facilities of his testing plant, and the coil was accordingly removed thither, and further tests

carried out under the supervision of Mr. Henry C. Louis of the company's electrical engineering department.

We forced 440 amperes of 60 cycle alternating current through the coil, with terminal potential drop of 32 volts. The flicker now became much more distinct than it had been at the lower amperage. Dr. Whitehead, Dr. Jennings and one of the students who before had not noticed any flicker, were present at these tests and now got the flicker very clearly at first trial. Mr. Louis and a number of the electricians also testified to the unmistakable nature of the phenomenon.

With 480 amperes of 25-cycle current (20 volts) a much more striking result was obtained. With my head below the level of the coil, and with my eyes open, the flicker was strongly noticeable, although the room was brightly lighted by afternoon daylight. The whole visual field quivered as if illuminated by a rapidly intermittent light. Several other subjects made a similar observation, although in some cases the flicker was noticed only in the less illuminated parts of the visual field, as where shadows fell in the room. With the head inside the coil the flicker was so pronounced as to be intensely disagreeable. The flicker seemed to me slower than with the 60-cycle current, and Mr. Louis and one of his assistants found the same apparent difference. Others were uncertain as to this point. The flicker with 60-cycle current had seemed to me to differ in character from ordinary visual flicker; it was odd, or novel in an indefinite way; but the flicker with 25-cycle current seemed quite like ordinary rapid flicker. This difference I am inclined to explain by the fact that normally a flicker of 60 per second is imperceptible, hence such a flicker seems unusual when produced under these abnormal conditions.

With the 200-ampere current, I had found that with the head either above or below the coil, with the face turned either upward or downward, practically no effect was obtained, although in two of these positions the eyes were close to the plane of the end of the coil, and hence in a strong magnetic field. Rota-

tion of the head from one of these positions through 90° (presenting the side of the head to the coil) brought in the flicker distinctly. My observation on this point was confirmed by Dr. Anderson and Dr. Watson. With the stronger currents the effect was much more pronounced. Although some flicker was observed when the occipito-frontal axis was vertical, rotation of the head through 90° caused a great increase. This would suggest that the effect is due to induction currents in the optic pathway, since in the position with occipito-frontal axis vertical, the general direction of the optic pathway is parallel to the lines of force, whereas rotation of the head through ninety degrees brings the pathway across the lines. When the head is inside the coil, the pathway crosses the lines in the most intense part of the magnetic field.

Whether currents induced in the optic pathway excite the occipital cortex directly, or excite the retina primarily, is yet a matter for conjecture. That flicker is produced by alternations faster than the fastest flicker from normal light stimulation is of course no evidence for the non-retinal character of the flicker in question.

I can not say as yet that there is a definite *arousal* of visual sensation by the alternating field; the effect appears more like an alternate intensification and inhibition of whatever sensory process is already in progress. That is to say: if a certain intensity of normal light-sensation or idio-retinal light is present before the current is turned on, the apparent effect of setting up the alternating field is alternately to increase and decrease the intensity of the sensation so that the average intensity is not changed. It is quite possible that further observation will change my opinion on this point.

No sensations other than the visual, which could be connected with the alternating field were noticed by any of us. That there is no after-effect from the stronger fields, I should not like to say at present. I should advise any experimenter to proceed cautiously.

It is very desirable that experiments with a

large range of amperages and frequencies be made, but I am not certain that I shall be able to carry these out in the near future. The difficulties in the way of securing adequate control of current when high amperages are used are greater than may appear to the casual reader.

KNIGHT DUNLAP

JOHNS HOPKINS UNIVERSITY,

December 20, 1910

THE GERM CELL DETERMINANTS IN THE EGGS OF
CHRYSOMELID BEETLES

PARTS of my papers on "The Origin and Early History of the Germ Cells in Some Chrysomelid Beetles,"¹ and "The Effects of Removing the Germ Cell Determinants from the Eggs of Some Chrysomelid Beetles"² have recently been subjected to criticism,³ which, it seems to me, needs some analysis. I have shown in these papers that a disc-shaped mass of darkly staining granules appears at the posterior end of the eggs of certain chrysomelid beetles just before deposition. Because of the shape of this mass and its position in the egg, I have called it the "pole disc." During the formation of the blastoderm, those cleavage products which, in their progress toward the periphery, encounter the pole disc granules, gather these about themselves and continue their migration, finally becoming entirely separated from the egg. They then lie in a compact group at the posterior end. These are the primordial germ cells; they can be traced back into the embryo, where they separate into two groups which become the germ glands. The conclusion was reached that the cleavage products "are potentially alike until in their migration toward the periphery they reach the 'keimhautblastem.' Then those which chance to encounter the granules of the pole disc are differentiated by their environment, *i. e.*, the granules, into germ cells; all the other cleavage products become somatic cells" (1908, p. 21).

¹ *Journ. Morph.*, Vol. 20, 1909, pp. 231-296.

² *Biol. Bull.*, Vol. 16, 1908, pp. 19-26.

³ Wieman, H. L., "The Pole Disc of Chrysomelid Eggs," *Biol. Bull.*, Vol. 18, 1910, pp. 180-187.

It was found to be possible to remove the pole disc from freshly laid eggs by pricking the posterior end with a needle and allowing them to flow out. Eggs operated upon in this way produced embryos and larvæ either without germ cells or with only a few. This experimental evidence, added to that derived from the morphological study, seemed to prove that the pole disc granules were necessary for the production of the primordial germ cells and, in fact, determined them as such. This led to the conclusion that the "granules of the pole disc are therefore either the germ cell determinants or the visible sign of the germ cell determinants" (1908, p. 21). Recent experiments give additional evidence. When the posterior ends of freshly laid eggs are killed with a hot needle, thus preventing the pole disc from taking part in development, no germ cells are produced in the embryos and larvæ which develop from them.

Wieman objects to the term "germ cell determinant" since "the term implies the attribute of certain potentialities that these granules have not been shown to possess" (1910, p. 180). He also objects to my hypothesis that the pole disc granules consist of chromatic material extruded by the nucleus of the oogonium, and claims that "the granules of the pole disc consist of particles derived from the food stream of the ovum that form an accumulation of the protoplasm in its posterior part" (1910, p. 187). This is no doubt correct. I did not attempt to discover the origin of these granules, but concluded that they were of nuclear material because of the derivation of similar substances in the early development of *Ascaris*, *Cyclops* and a number of insects. According to Wieman, "the granules are not all taken up by the cells in their migration and the greater part of them remains behind after the cells have passed through" (p. 186). This is certainly not the case in the four species of beetles that I have used in my work.

Wieman suggests several possibilities as to the ultimate origin and significance of the pole disc granules. These possibilities were

fully considered in my papers as the following quotations will show. Wieman says (p. 186), "The granules may therefore be of the nature of chromatin and actually represent the chromatin of the nurse cells. . . ." In my paper (1909, p. 274) is this statement, "the granules of the pole disc may be derived from the nuclei of the nurse cells which, in many insects, pass into the early oocytes." Again Wieman remarks (p. 186) "The fact that the pole disc occupies a position between the pole cells and the yolk gives a considerable foundation for regarding it as a source of nutrition for these cells." My suggestion reads as follows (1909, p. 275) "they may hasten the growth at the posterior pole of the egg, and that later they may possibly increase the vigor of the pole cells. That the pole cells need special means of nourishment is doubtless the case, for, contrary to the condition in the blastoderm cells, they are at an early period entirely separated from the yolk, and later use up energy in their migration."

Furthermore, Wieman unconsciously admits that the pole disc granules are really germ cell determinants in the following words (p. 186): "If then the pole disc represents a part of the nutritive stream of the ovum that has not been transformed into ordinary yolk, but instead has been reserved to supply the pole cells, the conclusion presents itself that the latter as a result of this special kind of nutrition, undergo a peculiar method of metabolism which differentiates them from the somatic cells."

An account of the significance of the germ cell determinants in chrysomelid beetles and other animals is now in press.⁴

R. W. HEGNER

UNIVERSITY OF MICHIGAN,

December 21, 1910

THE AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE
THE MINNEAPOLIS MEETING

REPORT OF THE GENERAL SECRETARY

THE sixty-second meeting of the American Association for the Advancement of Science

⁴ *American Naturalist*.

was held at the University of Minnesota, Minneapolis, December 27 to 31, 1910. The registered number of members in attendance was approximately 500, but the actual attendance was probably not far from 1,200. Both in registration and attendance the meeting was an advance upon those of St. Louis and New Orleans. It also furnished an illuminating answer to the question whether a successful and well-attended meeting can be held in the middle west.

All meetings of the sections and affiliated societies were held on the campus of the university, with the exception of the Thursday sessions of the botanists and the entomologists, which were held at the college of agriculture. Three public addresses were held. On Tuesday evening, the retiring president, Dr. David Starr Jordan, gave his address, "The Making of a Darwin," in Minneapolis. On Thursday evening, Mr. W. A. Bryan gave an illustrated public lecture on the Hawaiian volcano Kilauea. On Wednesday evening in St. Paul, Mr. A. B. Stickney delivered a public lecture on the subject, "Should Practical Agriculture and the Physical Development of Childhood be Added to the Curriculum of the Public Schools." Of general interest also was the symposium on aviation under the auspices of Section D on Friday, and the unusually well-attended dinner and convention of Sigma Xi on the afternoon of the same day.

Section A and the Chicago Section of the American Mathematical Society met for the most part in joint session, with a total of 34 papers. On Friday afternoon they considered the report of the Committee on the Teaching of Mathematics to Students of Engineering. Section B and the American Physical Society met constantly in joint sessions, at which 33 papers were presented. In addition, a general interest session in charge of Section B was held on Thursday morning, while in the afternoon, B and D met jointly for the reading of the vice-presidential addresses.

In accordance with the present plan, Section C held no meetings apart from a session for the delivery of the vice-presidential address. All sessions of the general program

were essentially joint sessions, though under the auspices of the American Chemical Society. Two addresses and 8 papers were presented at the general meetings. Sixteen papers were read before the Division of Agricultural and Food Chemistry, 12 before the Division of Fertilizer Chemistry, 4 before the Division of Pharmaceutical Chemistry, and 8 before the Chemical Education Section. The largest number of papers, 47, was given before the Division of Physical and Inorganic Chemistry; 44 were read before the Biological Section, 27 before the Industrial Chemists and Chemical Engineers, and 17 before the Division of Organic Chemistry.

Twelve papers were presented before Section D in the symposium on aeronautics, and 10 were given on the regular program. Before Section E, the program consisted of 5 papers on Economic Geology, 7 on Structural Geology, 7 on Glacial Geology and 6 on Geography. Section F and the Central Branch of the American Society of Zoologists met regularly in joint session, with a program containing 43 papers. Fifty-eight titles appeared on the programs of the Entomological Society of America and the American Association of Economic Entomologists. The meetings of the Association of Horticultural Inspectors were given largely to reports of committees and to discussions. Five zoological papers were also presented at the meetings of the American Microscopical Society.

Section G, the Botanical Society of America, and the American Phytopathological Society met regularly in joint session, except on Friday morning, when simultaneous sessions of the section and the pathologists were necessary to complete the program. The features were the special addresses before the joint session on Wednesday afternoon, under the auspices of Section G, and the symposium on plant pathology at the College of Agriculture on Thursday, under the auspices of the Botanical Society. An interesting innovation was a conference on botanical teaching at the close of the botanical dinner on Thursday evening. Seventy-one papers were presented at the botanical sessions. The program of the

Sullivant Moss Society consisted of 12 papers on mosses, liverworts and lichens. The American Nature-Study Society held three symposia on Friday, devoted to the subjects: "The School Garden as a Nature Study Laboratory," "Natural History Museums in Relation to Nature Study Instruction" and "The Organization of Nature Study."

Section H held no meeting, but the American Psychological Association and the Western Philosophical Association were both in session. The two met in joint session on Thursday, and in session with Section L on Wednesday. Thirty-four papers were presented. Twelve papers were read before Section I. The symposium before Section K was devoted to the subject, "Diseases due to Filterable Organisms." In addition, a number of papers were presented in the general program. Section L met in joint session with the American Psychological Association, for the discussion of the topic, "Educational Psychology," and in joint session with the American Federation of Teachers of the Mathematical and Natural Science to discuss the topic, "Methods of Testing the Results of Science Teaching." The section also held a general interest session on university extension teaching, in addition to the program of 7 reports on investigations in education. The meeting of the American Federation of Teachers of the Mathematical and Natural Sciences was devoted to the reports of committees on various subjects.

The important actions taken by the council at the Minneapolis meeting were as follows:

1. A committee on organization and correlation was appointed, consisting of nine members, of which four were to be members of the council. This committee reported the following recommendations: "The committee recommends to the council that each section, when the corresponding affiliated society is meeting at the same time and place, shall confine its sessions at the annual meeting preferably to half a day or at most to two half days, and that the sectional program shall include the address of the vice-president and a series of papers of general interest prepared by in-

vation issued by the committee of the section." The recommendation of the committee was adopted, and on motion the council resolved further that it regards with especial favor holding all sessions under the joint auspices of the section and the appropriate affiliated society.

2. A resolution was adopted as follows:

WHEREAS serious injury and injustice would be done to scientific societies and scientific journals should such societies be forbidden to send scientific journals to members by second-class postage,

Resolved, that the American Association for the Advancement of Science, meeting in Minneapolis, request the Postmaster General and the Committees on the Post Office of the Senate and the House of Representatives to give careful attention to the effects of any ruling of the department that might limit the advancement and diffusion of science in this country.

Resolved, that copies of these resolutions be sent to the Postmaster General and to members of the Committees on Post Office of the Senate and the House of Representatives.

The officers of the association were instructed, officially and in the name of the association, to take such steps as will aid in the passage of the Dodds bill.

3. The election of fellows of the association was placed upon the basis of professional work in science, in the hope that greater uniformity will thus be secured in the action of sectional committees.

4. The usual grant of \$200 was given to the Concilium Bibliographicum, and an additional grant of \$75 to Professor G. J. Peirce for continuing the study of organisms in brines.

The general committee voted to hold the next meeting of the association in Washington from December 27 to December 30, and to reaffirm the action contemplating meetings in Cleveland and Toronto for 1912 and 1913 respectively. The following officers were chosen for the Washington meeting:

President—C. E. Bessey, University of Nebraska.

Vice-presidents—Section A, Mathematics and Astronomy, E. B. Frost, Yerkes Observatory; Section B, Physics, R. A. Milliken, Chicago Uni-

versity; Section C, Chemistry, F. K. Cameron, Department of Agriculture, Washington; Section D, Mechanical Science and Engineering, C. S. Howe, Case School of Applied Science; Section E, Geology and Geography, Bohumil Shimek, University of Iowa; Section F, Zoology, H. F. Nachtrieb, University of Minnesota; Section G, Botany, F. C. Newcombe, University of Michigan; Section H, Anthropology and Psychology, G. T. Ladd, Yale University; Section I, Social and Economic Science, no election; Section K, Physiology and Experimental Medicine, Dr. W. T. Porter, Harvard University; Section L, Education, E. L. Thorndike, Columbia University.

General Secretary—John Zeleny, University of Minnesota.

Secretary of the Council—T. S. Palmer, Washington, D. C.

FREDERIC E. CLEMENTS,
General Secretary

SECTION A—MATHEMATICS AND ASTRONOMY

As the Chicago Section of the American Mathematical Society held its regular Christmas meeting in affiliation with the American Association, the special program of Section A did not include any technical mathematical papers. The "general interest session" of the section was held on Wednesday afternoon. This was a joint session of the Chicago Section of the American Mathematical Society and of Section A, and the program of the session consisted of the vice-presidential address by Professor E. W. Brown, of Yale University, and the papers by F. R. Moulton and E. B. Frost, of the University of Chicago.

A very interesting feature of the meeting was the joint session of Sections A and D and the Chicago Section of the American Mathematical Society. This session was devoted to the report of the committee of twenty, appointed at a similar meeting in Chicago, in December, 1907, on the question: The teaching of mathematics to students of engineering. During the evening preceding this meeting members of Sections A, B and D and the Chicago Section of the American Mathematical Society discussed informally questions relating to this report and were afforded excellent opportunities to become better acquainted.

In the absence of their authors the papers by J. E. Siebel and H. E. Wetherill were read by title. The papers by J. A. Parkhurst and Percival Lowell were read by E. B. Frost and Frederick Slocum, respectively. All the other papers of the

following list were read by the authors during the three sessions of Section A.

1. "The Relations between Jupiter and the Asteroids" (vice-presidential address), E. W. Brown.
2. "The Contributions of Astronomy to Mathematics," F. R. Moulton.
3. "On some possible Bases for the Spectral Classification of Stars," E. B. Frost.
4. "Apparent Photographic Star-streams and their Relations to some of the Vacant Regions of the Sky," E. E. Barnard.
5. "Photographic Observations of the Surface of the Planet Mars," E. E. Barnard.
6. "An Integrable Case in the Problem of three Bodies," W. D. MacMillan.
7. "Photographic Position of 127 Stars within Ten Minutes of the Ring Nebula of Lyra," F. P. Leavenworth.
8. "Preliminary Report on the Evidences of Circulation in the Atmosphere of the Sun, Derived from the Study of Solar Prominences," Frederick Slocum.
9. "On the Choice of Standard Stars in Photographic Stellar Photometry," J. A. Parkhurst.
10. "The Oblateness of the Earth," J. E. Siebel.
11. "Dials for Calculations," H. E. Wetherill.
12. "Parallax of Ring Nebula of Lyra from Photographs taken at the Lick Observatory," B. L. Newkirk.
13. "Spectrum of Ring Nebula of Lyra," K. Burns.
14. "The Sun as a Star," Percival Lowell.

The addresses by E. W. Brown and F. R. Moulton will appear in *SCIENCE*. Abstracts of the other papers follow, the numbers preceding these abstracts correspond to the titles in the list given above.

3. There are numerous possibilities in the selection of a basis for the establishment of a system of stellar classification according to spectra. Emphasis may be laid upon the differences of a physical sort between stars, such as temperature, as inferred from the extension of the spectrum toward the violet, or from measurements of the radiation at different wave-lengths or differences of a chemical sort may be made the criterion, according to the elements found in the spectra. Again, theoretical reasons based upon the dynamics of the case may be regarded as especially important; or deductions from some hypothesis of stellar evolution may be considered as the most logical basis for discrimination. Even the motions of the stars, or the space within which they

are found, may have a bearing upon the subject, as, for instance, in the case of the streams of stars recently discovered and lately much discussed.

The paper gives a brief general discussion of some of these points, with lantern illustrations of different celestial spectra.

4. There are frequently seen, on wide field photographs of the sky, lines of stars either straight or curved, and sometimes in the form of more or less complete ellipses with a brighter star in a focus of the ellipse. It is probable that most of these stars are not physically connected, and appear so only by perspective. But it does not seem probable that all these appearances are due to fortuitous circumstances alone.

Besides these lines and curves of stars, so striking in some parts of the sky, there are apparently broad streams of stars which seem to have a common trend. This appearance usually occurs in a very dense region, and resembles that which might be produced by the sweep of a giant broom. In some cases these "sweeps" are apparently connected with vacant regions, as if there were a common drift of the stars away from these places. A striking case of this kind occurs in *Scutum*, where the appearance is that of streams of stars diverging away from or converging to a vacant region at this point.

5. During the opposition of Mars in 1909 efforts were made to secure photographs of its surface features with the 40-inch refractor and a negative enlarging lens made by Brashear. For this purpose a yellow color screen, made especially for the work by Mr. Wallace, with Cramer instantaneous isochromatic plates, was used. Though the exposures were short (three or four seconds), it was found necessary to guide on the planet during the exposure. In the eyepiece of the long-focus (61½ feet) guiding telescope two cross-wires (spider threads) were inserted. In making the photographs the polar cap of the planet was bisected by these cross-lines, and the telescope held firmly in this position by pressure exerted at the eye-end of the 40-inch. The cross wires are on a perforated strip of sheet brass (with an opening a couple of inches in diameter) that can be shoved back and forth through a slit in the adapter carrying the eyepiece. It is also arranged to move in position angle.

For photographing Jupiter and Saturn, where there is nothing definite to guide on, the intersection of the wires can be made to bisect a satellite, after the image of the planet has been

properly adjusted in the camera. The wires are then held firmly on the satellite, as in the case of the polar cap of Mars.

The conditions of seeing necessary for success in this class of work were almost entirely absent during the opposition of Mars. There was only one night, 1909, September 28, on which the conditions were favorable, and this for a short time only. The best results are therefore meager, but the promise of success is good when conditions will permit the best work.

The photographs of September 28 show the region of the Syrtis Major. They contain essentially all the details that could be seen with the same telescope visually.

6. Dr. MacMillan shows that if two of the masses are finite and equal and revolve about their common center of gravity in circles, and if the third mass is infinitesimal and is projected in the axis of revolution of the two finite bodies then the motion of the infinitesimal body can be determined by means of elliptic functions. If the velocity of projection is not too great the motion of the infinitesimal is periodic and it is shown how to construct periodic series representing the motion.

7. Twenty-two photographs were made with the 10½-inch telescope of the University of Minnesota between the years 1897-1910. Ten plates were measured and reduced to standard of October 19, 1909. The faintest stars measured were about fourteenth magnitude. No variability in brightness was detected. The proper motions are all less than $0''.1 \pm 0''.01$ per year. The measures have not yet been discussed for parallax.

8. From a study of 3,300 solar prominences, by Dr. Slocum, photographed in the light of the H-line of calcium with the Rumford spectroheliograph of the Yerkes Observatory during the past seven years, 1,100 were found which by their shapes or movements indicate a horizontal circulation. The tendency is poleward between latitudes 20° and 55° , equatorward beyond 55° , and neutral near the equator. The contrast of tendency is greater in the northern hemisphere than in the southern in the ratio of 2 to 1. The average height above the chromosphere of the prominences studied is 0.7 or 30,000 km. The earlier plates do not afford data for determining velocities. From the later plates low prominences of the cloud type give apparent velocities from 1 to 10 km. per second. One detached cloud at a height of 7' or 300,000 km. shows a horizontal velocity of 50 km. per second, while eruptive

prominences have been observed the north and south horizontal component of whose velocity reaches 200 km. per second.

9. The paper by Mr. Parkhurst deals with the relative advantages of two proposed systems of standard magnitude stars; those in the neighborhood of the pole, and the white stars in the particular region photographed. It compares the possible errors arising from differences of transparency of the sky when a distant region is referred to the polar standards with the errors due to the magnitudes of stars found in the visual catalogues of the region photographed, and the uncertainties due to the allowance made for spectral type of these standards.

10. In accordance with experimental demonstrations devised by Dr. Siebel, the ellipticity of the earth may be considered as the result in part of the withdrawal of a greater amount of kinetic energy in one of the three directions (in which the molecular motions of a liquid subjected only to its own internal forces may be resolved) during its congelation or solidification. For the experimental demonstration of this phenomenon a drop of water is suspended in a mixture of Beechwood Creosote and ether, which is cooled sufficiently to make the drop of water congeal almost at once. The moment when this takes place, the perfect globular shape of the drop changes into an ellipsoidal form, whereby the vertical diameter of the same is reduced at least one fourth; the now solid and flattened drop, on account of the lower density acquired, rises slowly to the surface.

11. A particular kind of dials useful in certain calculations were discussed in the paper by Dr. Wetherill.

12. The present investigation is based on measures of seventeen plates made with the Crossby reflector of the Lick Observatory. It proves impossible to separate the parallax from atmospheric dispersion without further observational material which the Lick Observatory will provide. In addition to masking the effect of parallax the atmospheric dispersion produces shifts of the position of the central star amounting to $0''.2$.

Photographs made with a reflector are probably more subject to the effects of atmospheric dispersion than those made with a refractor.

Certain hitherto unexplained discordances in visual observations of the central star may be due to dispersion.

13. True photographs of the nebula were taken with the slitless spectroscope of the Crossby

reflector of the Lick Observatory. Spectrum on the stained plate was compared with spectra on ordinary plates. The spectrum of central star is continuous and like spectra of central star of planetary nebulae. The spectrum of central star is relatively stronger in ultra-violet light than the bluest of the Orion type of stars. The distribution of elements in the nebulous ring are probably not identical.

14. The conclusions reached in the paper by Percival Lowell are: That parallaxes beyond $0''.067$ are too small to be trustworthy, and that the masses of those stars for which alone we have dependable data are, in the mean, almost exactly the same as that of the sun.

The following members of Section A were elected as fellows: M. J. Babb, E. W. Bass, H. Y. Benedict, G. D. Birkhoff, A. B. Chace, Arnold Dresden, Eric Doolittle, J. C. Duncan, T. C. Esty, Max Fischer, G. W. Hartwell, H. G. Keppel, A. S. Hawkesworth, T. H. Hildebrandt, N. J. Lennes, W. H. Maltbie, Max Mason, Helen A. Merrill, E. J. Miles, A. B. Pierce, A. R. Schweitzer, F. H. Seares, Mary E. Sinclair, Clara E. Smith, E. R. Smith, A. W. Stamper, A. L. Underhill, C. E. Van Ostrand, F. W. Very, W. D. A. Westfall, E. J. Wilczynski, F. B. Williams, T. W. D. Worthen, E. I. Yowell. The section elected President E. O. Lovett member of the council, President C. S. Howe member of the sectional committee, and Dean H. T. Eddy member of the general committee. On recommendation of the sectional committee Professor E. B. Frost, director of the Yerkes Observatory, was elected chairman of the section.

G. A. MILLER,
Secretary of Section A

UNIVERSITY OF ILLINOIS

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

THE 68th regular meeting of the society was held at the Cosmos Club, Friday, December 16, 1910, at eight o'clock P.M. President W. J. Spillman presided. Thirty members were in attendance. H. A. Edson, E. P. Humbert, F. J. Pritchard and W. H. Long were admitted to membership.

The following papers were read:

Propagation of Sea Island Cotton: Dr. W. H. EVANS.

An account was given of the work of the Hawaii Agricultural Experiment Station with

cotton, especial attention being called to the vegetative propagation of the cotton plant. At the Hawaii Station experiments with Sea Island and Caravonica cottons have been in progress for several years, and it has been found advantageous to grow them as perennial crops, pruning the plants every year, the Sea Island to about six or eight inches of the previous year's growth and the Caravonica about one half the growth of the season preceding. After pruning, the plants start growth rapidly and within five months are producing squares. By paying attention to the time of pruning, harvesting can be regulated to come at a time when picking can be most economically done. In the experiments described above, the prunings have been taken as cuttings, rooted, and then set into the field. In this way a number of superior strains have been propagated without the possibility of crossing. As the older plants yield fifty to one hundred cuttings at a pruning and practically all root quickly, this is not as slow a method of propagating as would be at first thought.

In addition to increasing cotton by cuttings, it has been found possible to propagate it by budding and grafting, and a considerable number of plants have been successfully top-worked with especially fine strains of cotton.

Pecan Scab: M. B. WAITE.

The pecan, being a native forest tree, is not as subject to destructive outbreaks of fungous diseases as other cultivated nuts and fruits. It is native of the Mississippi Valley as far north as Iowa and central Illinois, and extends eastward into Alabama and westward into Texas. It is mainly planted in commercial orchards throughout the cotton belt, but particularly in the district where sugar cane can be cultivated. It is not expected, therefore, that the pecan should have such destructive diseases as the bacterial blight of the English walnut, pear-blight of the pear and apple, yellows of the peach tree, or the black-rot, downy mildew or phylloxera of the European grape when the latter is grown in the eastern United States.

There is an apparent exception to this in the pecan scab, caused by the fungus *Fusicladium effusum* Winter. This exception comes about through the transfer of seedlings and horticultural varieties, such as San Saba and Sovereign which originated on the western limit of the pecan in Texas, where the summers are dry, to the humid conditions of the gulf coast states and the Carolinas. The Texas group of varieties are

often severely attacked by the scab fungus, particularly on the nuts, and the crop partially or totally destroyed. The *Fusicladium* attacks the young leaves as they unfold in the spring. The young leaflets and the leaves are successively attacked through the growing season while they are developing. Each leaf and leaflet as it reaches maturity becomes immune, or nearly so, to the fungus infections. The fungus also attacks the young growing twigs, but particularly the nuts. The nuts continue to develop through the summer and remain susceptible until late in September.

Infections take place at definite periods, namely, the warm, rainy, humid spells that occur so frequently in the southeastern states. An interesting feature was found in relation to the life history of the disease, namely, that a plant louse which becomes common on the pecan in May punctures the epidermis in a regular way along the veins and veinlets. The punctures of this plant louse are used as points of entrance by the *Fusicladium*. The fungus can also enter in the direct way and such diseased spots are irregularly located over the leaves, fruit and twigs, but the spots due to aphid infections are arranged in regular lines along the veinlets and far exceed in number all other spots on the leaves. The fungus evidently is also assisted in its germination and growth by the honey dew copiously secreted by these aphids.

Spraying experiments showed that bordeaux mixture controlled the scab thoroughly and is probably the best fungicide for treating it. Diluted lime-sulphur solution also controlled the scab nearly as well and killed the aphids, thus making it a promising mixture to use, at least in part of the treatments. The unfortunate fact that the nuts remain susceptible throughout the summer makes treatment difficult and expensive, so that four or five, and even six sprayings may be necessary for success.

Extensive observations through the south by a number of pecan students, as well as the experience of practical pecan growers and nurserymen, have shown that a large number of varieties are reasonably resistant to this disease. These varieties have nearly all originated from Louisiana stock, or at least from trees grown in the humid regions adjacent to the Mississippi and the gulf. Since many of the finest paper-shell varieties are commercially resistant to the scab fungus, they should, of course, be selected for cultivation in the humid southeastern states. Furthermore, instead of recommending the treatment by spraying

of the badly scabbing varieties, it is suggested that these varieties, as well as susceptible seedlings, be top-worked to resistant sorts.

Bubonis' Flora Pyrenæa: Dr. E. L. GREENE.

W. W. STOCKBERGER,
Corresponding Secretary

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 40th annual meeting (686th regular meeting) was held on December 17, 1910. President Woodward in the chair.

After hearing the reports of the secretaries, the treasurer and the auditing committee, the annual election for the selection of officers for the calendar year 1911 was taken up, and the following officers were duly elected:

President—A. L. Day.

Vice-presidents—L. A. Fischer, C. G. Abbot, E. B. Rosa and G. K. Burgess.

Treasurer—L. J. Briggs.

Secretaries—R. L. Faris and W. J. Humphreys.

General Committee—E. Buckingham, W. S. Eichelberger, E. G. Fischer, B. R. Green, R. A. Harris, P. G. Nutting, F. A. Wolff, W. A. DeCaindry and J. A. Fleming.

After the election of officers a buffet luncheon was served.

R. L. FARIS,
Secretary

THE AMERICAN CHEMICAL SOCIETY NORTHEASTERN SECTION

THE one hundredth meeting of the section was celebrated by a dinner held at the Exchange Club, Boston, on December 16. President Wilder presided, and there were one hundred members and guests present.

The evening was devoted to a consideration of "The Conservation of our Natural Resources." Hon. Curtis Guild, Jr., ex-governor of Massachusetts, spoke on the conservation of forests for the sake of both timber and water, and he urged the duty of the federal government to provide national reservations in the east as well as in the west.

Mr. H. M. Wilson, of Pittsburgh, assistant chief of the Bureau of Mines of the Department of Commerce and Labor, described the work of this bureau and dwelt particularly on the progress in the prevention of coal mine disasters and in the care of injured miners.

KENNETH L. MARK,
Secretary